Report of the Tenth Session of the IOTC Working Party on Billfish

Cape Town, South Africa, 11–15 September 2012

DISTRIBUTION:

- Participants in the Session
- Members of the Commission
- Other interested Nations and International Organizations
- FAO Fisheries Department
- FAO Regional Fishery Officers

BIBLIOGRAPHIC ENTRY

IOTC–WPB10 2012. Report of the Tenth Session of the IOTC Working Party on Billfish. Cape Town, South Africa, 11–15 September 2012. *IOTC–2012–WPB10–R[E]: 66 pp.*

Indian Ocean Tuna Commission
Commission des Thons de l'Ocean Indien
iotc ctoi

Contact details:

Indian Ocean Tuna Commission
Le Chantier Mall
PO Box 1011
Victoria, Mahé, Seychelles
Ph: +248 4225 494
Fax: +248 4224 364
Email: secretariat@iotc.org
Website: http://www.iotc.org

ACRONYMS

AIC	Akaike Information Criterion
ASPIC	A Stock-Production Model Incorporating Covariates
B	Biomass (total)
B_{MSY}	Biomass which produces MSY
BLM	Black marlin
BSH	Blue shark
BUM	Blue marlin
CE	Catch and effort
CI	Confidence Interval
CMM	Conservation and Management Measure (of the IOTC; Resolutions and Recommendations)
CPCs	Contracting parties and cooperating non-contracting parties
CPUE	Catch per unit of effort
current	Current period/time, i.e. $F_{current}$ means fishing mortality for the current assessment year.
EU	European Union
EEZ	Exclusive Economic Zone
F	Fishing mortality; F_{2010} is the fishing mortality estimated in the year 2010
FAO	Food and Agriculture Organization of the United Nations
F_{MSY}	Fishing mortality at MSY
GLM	Generalised liner model
HBF	Hooks between floats
IO	Indian Ocean
IOTC	Indian Ocean Tuna Commission
IOSSS	Indian Ocean Swordfish Stock Structure
LL	Longline
M	Natural Mortality
MSY	Maximum sustainable yield
n.a.	Not applicable
NGO	Non-governmental organization
PS	Purse-seine
PSAT	Pop-up satellite tag
q	Catchability
ROP	Regional Observer Programme
SC	Scientific Committee of the IOTC
SB	Spawning biomass (sometimes expressed as SSB)
SB_{MSY}	Spawning stock biomass which produces MSY
SFA	Indo-Pacific sailfish
SS3	Stock Synthesis III
STM	Striped marlin
SWIOFP	South West Indian Ocean Fisheries Project
SWO	Swordfish
Taiwan,China	Taiwan, Province of China
WPB	Working Party on Billfish of the IOTC
WPTT	Working Party on Tropical Tunas of the IOTC

TABLE OF CONTENTS

EXECUTIVE SUMMARY

The Tenth Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Cape Town, South Africa, from 11 to 15 September 2012. A total of 23 participants attended the Session, including one invited expert, Dr. Humber Andrade, from the Universidade Federal Rural de Pernambuco, Brazil.

The following are a subset of the complete recommendations from the WPB10 to the Scientific Committee, which are provided at Appendix IV.

The WPB **NOTED** the main marlin data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI, and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting. (para. 36)

The WPB **RECOMMENDED** that both Japan and Taiwan,China undertake a complete historical review of their longline data and to document the changes in fleet dynamics for presentation and the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data. (para. 85)

The WPB **RECOMMENDED** that the SC note the management advice developed for marlins as provided in the draft resource stock status summaries: (para. 110)

- Black marlin (*Makaira indica*) – Appendix VII
- Blue marlin (*Makaira nigricans*) – Appendix VIII
- Striped marlin (*Tetrapterus audax*) – Appendix IX

The WPB **RECOMMENDED** that the SC note the management advice developed for Indo-Pacific sailfish *(Istiophorus platypterus)*, as provided in the draft resource stock status summary (Appendix X). (para. 119)

The WPB **RECOMMENDED** that the SC note that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision. (para. 127)

The WPB **RECOMMENDED** that scientists from EU,Portugual and EU,Spain undertake a revised CPUE analysis for their longline fleets, and consider combining the analysis prior to the next WPB meeting where swordfish will be dealt with as a priority. (para. 130)

The WPB **RECOMMENDED** that the SC note the management advice developed for swordfish (*Xiphias gladius*), as provided in the draft resource stock status summary (Appendix XI). (para. 139)

NOTING that despite the mandatory reporting requirements detailed in Resolutions 10/02 and 12/03 data on billfish fisheries, in particular for the marlins, remain largely unreported by CPCs; thus the WPB **RECOMMENDED** that the SC address these concerns to the Compliance Committee and the Commission in order for them to take steps to develop mechanisms which would ensure that CPCs fulfill their reporting obligations. (para. 156)

The WPB **RECOMMENDED** that the SC consider the consolidated set of recommendations arising from WPB10, provided at Appendix IV. (para. 157)

A summary of the stock status for billfish species under the IOTC mandate is provided in Table 1.

Table 1. Status summary for billfish species under the IOTC mandate.

Stock	Indicators	Prev[1]	2010	2011	2012	Advice to Commission
Swordfish (whole IO) *Xiphias gladius*	Catch 2010: 21,326 t Average catch 2006-2010: 24,008 t MSY: 29,900 t–34,200 t F_{2009}/F_{MSY}: 0.50–0.63 SB_{2009}/SB_{MSY}: 1.07–1.59 SB_{2009}/SB_0: 0.30–0.53	2007				At this time, annual catches of swordfish should not exceed 30,000 t. If the recent declines in effort continue, and catch remains substantially below the estimated MSY, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
Swordfish (southwest IO) *Xiphias gladius*	Catch 2010: 8,112 t Average catch 2006-2010: 7,441 t MSY: 7,100 t–9,400 t F_{2009}/F_{MSY}: 0.64–1.19 SB_{2009}/SB_{MSY}: 0.73–1.44 SB_{2009}/SB_0: 0.16–0.58					At this time, annual catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678), until there is clear evidence of recovery and biomass exceeds B_{MSY}. Although the catches of swordfish in the southwest Indian Ocean increased in 2010 to 8,112 t, which equals 121.5% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011, this is not considered to be a major threat to the status of the stock as the probabilities of violating target reference points in 2012 by catching 120% of the recommended catch are less than 18% for F_{MSY} and less than 30% for B_{MSY}.
Black marlin *Makaira indica*	Catch 2010: 6,935 t Average catch 2006–2010: 6,085 t MSY: Unknown					No quantitative stock assessments are currently available for these species in the Indian Ocean. The Maximum Sustainable Yield estimates for the whole Indian Ocean is unknown and annual catches need to be reviewed. Improvement in data collection and reporting is required to assess these stocks. However, aspects of species biology, productivity and fisheries combined with a lack of fisheries data on which to base quantitative assessments is a cause for concern.
Blue marlin *Makaira nigricans*	Catch 2010: 10,660 t Average catch 2006–2010: 9,246 t MSY: Unknown					
Striped marlin *Tetrapturus audax*	Catch 2010: 2,090 t Average catch 2006–2010: 2,531 t MSY: Unknown					
Indo-Pacific Sailfish *Istiophorus platypterus*	Catch 2010: 31,650 t Average catch 2006–2010: 26,077 t MSY: Unknown					

[1]This indicates the last year taken into account for assessments carried out before 2010

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		
Not assessed/Uncertain		

1. Opening of the Session

1. The Tenth Session of the Indian Ocean Tuna Commission's (IOTC) Working Party The Tenth Session of the Indian Ocean Tuna Commission's (IOTC) Working Party on Billfish (WPB) was held in Cape Town, South Africa, from 11 to 15 September 2012. A total of 23 participants attended the Session. The list of participants is provided at Appendix I.

2. The meeting was opened on 11 September, 2012 by the Chair, Dr Jérôme Bourjea, who welcomed participants to Cape Town, South Africa. The participants were also welcomed by Dr. Johann Augustyn, Chief Director, Fisheries Research and Development, from the Department of Agriculture, Forestry and Fisheries of South Africa.

2. Adoption of the Agenda and Arrangements for the Session

3. The WPB **ADOPTED** the Agenda provided at Appendix II. The documents presented to the WPB10 are listed in Appendix III.

4. **NOTING** that several key working papers were provided either immediately prior to, or on the morning of the meeting, thereby making it difficult or impossible for all participants to thoroughly review and therefore be able to comment and contribute to discussions during the meeting, the WPB **URGED** all authors to ensure that they comply with the recommendation from the Scientific Committee (SC) that all working party papers need to be submitted to the IOTC Secretariat no later than 15 days prior to the relevant meeting.

3. Outcomes of the Fourteenth Session of the Scientific Committee

5. The WPB **NOTED** paper IOTC–2012–WPB10–03 which outlined the main outcomes of the Fourteenth Session of the Scientific Committee (SC14), specifically related to the work of the WPB.

6. The WPB **NOTED** the recommendations of the SC14 on data and research, and agreed to consider how best to progress these issues at the present meeting, in particular on the CPUE analysis of marlins and sailfish, with a core focus on striped marlin.

4. Outcomes of Sessions of the Commission

4.1. Outcomes of the Sixteenth Session of the Commission

7. The WPB **NOTED** paper IOTC–2012–WPB10–04 which outlined the main outcomes of the Sixteenth Session of the Commission, specifically related to the work of the WPB.

8. The WPB **NOTED** the 15 Conservation and Management Measures (CMMs) adopted at the sixteenth Session of the Commission (consisting of 13 Resolutions and 2 Recommendations), and in particular the following three Resolutions which have a direct impact on the work of the WPB: Resolution 12/01 *on the implementation of the precautionary approach*; Resolution 12/03 *on catch and effort recordings by fishing vessels in the IOTC area of competence*; and Resolution 12/11 *On the implementation of a limitation of fishing capacity of Contracting Parties and Cooperating non-Contracting Parties*.

9. The WPB **NOTED** the Commission's recognition that the Kobe II strategy matrix is a useful and necessary tool for management, and requested that such a matrix shall be provided for all stock assessments by the species Working Parties, and for these to be included in the report of the SC in 2012 and all future reports.

10. The WPB **NOTED** the outcomes of the Sixteenth Session of the Commission, and agreed to consider how best to provide the SC with the information it needs, in order to satisfy the Commission's requests, throughout the course of the meeting.

4.2. Review of Conservation and Management Measures (CMMs) relating to billfish

11. The WPB **NOTED** paper IOTC–2012–WPB10–05 which aimed to encourage the WPB to review the existing CMMs relating to billfish, and as necessary to 1) provide recommendations to the SC on whether modifications may be required; and 2) recommend whether other CMMs may be required.

12. The WPB **AGREED** that it would consider proposing modifications for improvement to the existing CMMs following discussions held throughout the current WPB meeting.

5. Progress on the Recommendations of WPB09

13. The WPB **NOTED** paper IOTC–2012–WPB10–06 which provided an update on the progress made in implementing the recommendations from previous WPB meetings, and also provided alternative recommendations for the consideration and potential endorsement by participants.

14. The WPB **AGREED** to a set of revised recommendations, that are provided throughout this report and in the consolidated list of recommendations (Appendix IV), for the consideration of the SC.

Billfish species identification

15. The WPB **NOTED** paper IOTC–2012–WPB10–08 which provided an update on the progress made in developing identification cards for billfish species caught in IOTC fisheries.

16. The WPB **REQUESTED** that the IOTC Secretariat finalize the cards prior to the Fifteenth Session of the SC, and undertake an initial print run using any surplus funds from the IOTC budget for 2012.

17. The WPB **RECOMMENDED** that the SC request that the Commission allocate additional funds in 2013 to print further sets of the identification cards, noting that expected costs are in the vicinity of US$5,500 per 1000 sets of cards.

18. The WPB **RECOMMENDED** that IOTC CPCs translate, print and disseminate the identification cards to their observers and field samplers (Resolution 11/04), and as feasible, to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on billfish to be recorded and reported to the IOTC Secretariat as per IOTC requirements.

19. The WPB **ENCOURAGED** all CPCs to implement training sessions on billfish identification to improve the quality of data collected in the field for their observers.

Length-age keys

20. The WPB **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Catch, Catch-and-effort, Size data

21. The WPB reiterated its **RECOMMENDATION** from 2011 that the IOTC Secretariat liaise with the EU,Spain in order to assess and improve the status of catch-and-effort data for marlins and sailfish.

22. The WPB reiterated its previous **RECOMMENDATION** that the EU,Spain longline fleet provide the IOTC Secretariat with catch-and-effort and size data of marlins and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

23. The WPB reiterated its previous **RECOMMENDATION** that Japan resume size sampling on its commercial longline fleet, and that Taiwan,China provide size data for its fresh longline fleet to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

24. The WPB reiterated its previous **RECOMMENDATION** that Indonesia and India provide catch-and-effort and size frequency data for their longline fleets.

25. The WPB reiterated its previous **RECOMMENDATION** that CPCs having artisanal and semi-industrial fleets, in particular Iran, Pakistan, Sri Lanka, provide catch and effort as well as size data as per IOTC requirements for billfish caught by their fleets.

26. The WPB **NOTED** that all CPCs are not collecting size with standard measurements, and **RECOMMENDED** that only lower-jaw to fork length, eye to fork length or pectoral to second dorsal length are taken by fisher, samplers and observers.

27. The WPB reiterated its previous **RECOMMENDATION** that the EU record and report information on catches of billfish, by species, for its purse seine fisheries.

Data inconsistencies

28. Noting the progress made to date, the WPB **RECOMMENDED** that the IOTC Secretariat finalize the study aimed at assessing the consistency of average weights derived from the available catch and effort data, as derived from logbooks, and size data provided by Japan, Taiwan,China, Seychelles and EU,Spain and to report final results at the next WPB meeting.

29. The WPB reiterated its **RECOMMENDATION** from 2011 that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement. As part of this process, these CPCs shall use the billfish identification cards to improve the identification of marlin species caught by their fisheries.

Sports fisheries

30. **NOTING** that in 2011, the Chair of the WPB, in collaboration with the IOTC Secretariat, participating billfish foundations and other interested parties, commenced a process to facilitate the acquisition of catch-and-effort and size data from sport fisheries, by developing and disseminating reporting forms to Sport Fishing Centres in the region, the WPB **REQUESTED** that the Chair and Vice-Chair work in collaboration with the IOTC Secretariat to develop a concept note for a project aimed at enhancing data recovery from sports and other recreational fisheries in the western Indian Ocean region. The WPB Chair should circulate the concept note to potential funding bodies on behalf of the WPB. A similar concept note could be developed for other regions in the IOTC area of competence.

31. The WPB **REQUESTED** that the African Billfish Foundation continue its important work, particularly in the areas of collaborative research aimed at obtaining more information on movements of billfishes, via both conventional and archival tagging programs that will allow the collection of information on both horizontal and vertical movements as well as on population dynamics.

32. The WPB **NOTED** paper IOTC–2012–WPB10–INF07 which provided an update on the Oceanographic research institute's (ORI) voluntary fish tagging project.

33. The WPB **NOTED** the value of such tagging projects on recreational fisheries and encourage the authors to provide a further update at the next WPB meeting.

34. The WPB **RECOMMENDED** that the IOTC Secretariat develop a list of contacts of Institutes, Foundations and NGOs implementing tagging programs of large pelagic fishes in the Indian Ocean and to summarise this information for presentation at the next WPB meeting.

6. MARLINS

6.1. Review of data available at the Secretariat for marlins

35. The WPB **NOTED** paper IOTC–2012–WPB10–07 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for marlins, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2010. Statistics for 2011 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October). The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching marlins in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, and size-frequency. A summary of the supporting information for the WPB is provided in Appendix V.

36. The WPB **NOTED** the main marlin data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI, and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

37. The WPB **NOTED** that the quality of the data available at the IOTC Secretariat on marlins is likely to be compromised by species miss-identification and **RECOMMENDED** that CPCs review their historical data in order to identify and correct potential identification problems that are detrimental to any analysis of the status of the stocks.

6.2. Review of new information on the biology, stock structure, fisheries and associated environmental data

Sri Lankan billfish landings

38. The WPB **NOTED** paper IOTC–2012–WPB10–09 which provided an analysis of billfish landings made by small fresh tuna longline vessels operated from Sri Lanka during 2005–2009, including the following abstract provided by the authors:

“*The paper reviews the fish landings made by small fresh tuna longline vessels operated from Sri Lanka during 2005 – 2009 giving special emphasis to billfish landings. Small fresh tuna longline vessels are inboard engine boats having fish storage facilities, which may also have a Refrigerated Sea Water (RSW) system or Chilled Sea Water (CSW) system with some other modem equipment such as GPS and echo-sounder/fish finder. There are about thirty such tuna longline vessels being operated in Sri Lanka. These vessels normally target tuna and tuna-like species and operate either in the offshore waters within the EEZ of Sri Lanka or in the high seas. The fishery data used for this audit was mainly obtained from the catch records of the local fishing companies. The information includes the vessel name, number of individuals landed, weight and name of the species. Tuna is the key target species and has contributed around 60% of the total landings made by small fresh tuna longline vessels. Billfish which includes three species of marlins, one species of sailfish and one species of sword fish, have contributed over 30% of the total catch. This is a remarkably high proportion of the total catch when compared to the fish landings made by other Sri Lankan fishing vessels engaged in offshore or high sea fishing. However, a slight declining trend in the percentage of billfish landings (from 34% to 26%) was observed over the period. The key billfish species found in the landings is swordfish (Xiphias gladius). Surprisingly, this species has contributed over 75% to the total billfish landings. The study further revealed that small fresh tuna longline vessels operate differently from other fishing crafts engaged in multiday fishing in Sri Lanka.*”

39. **NOTING** that to date, Sri Lanka has been unable to provide accurate statistics for billfish species to the IOTC, due to poor species identification and low levels of sampling coverage for its coastal and offshore fisheries; the WPB **RECOMMENDED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission (1 fish by metric ton of catch by type of gear and species), including:

- catches sampled or observed for at least 5% of the vessel activities for coastal fisheries, including collection of catch, effort and size data for IOTC species and main bycatch species;
- implementation of logbook systems for offshore fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03.

The information collected through the above activities should allow Sri Lanka to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

40. The WPB **AGREED** that although there are currently no sports fishery data collection programs in Sri Lanka, such programs would be highly beneficial given the rapidly expanding sports fishing industry operating in Sri Lankan waters.

Madagascar’s billfish landings

41. The WPB **NOTED** paper IOTC–2012–WPB10–10 which provided an analysis of catch and effort for billfish by Malagasy longliners from 2010 to 2011, including the following abstract provided by the authors:

“*This is the first time since joining the IOTC that Madagascar’s scientist could produce a scientific paper that examines the catch per unit effort (CPUE) of its longliners’ fishing activities which evolve exclusively in the eastern part of its fishing area. Note that the database for the acquisition of these results is obtained by the declarative system of fishing companies that do not require ship owners to declare their fishing activities systematically. Anomalies such as the data inconsistency or lack of information on fishing efforts, were noted in such statements. Estimates have been done about efforts to be able to produce such article while being aware of error induced by the method adopted. Monthly CPUE (Kg/1000 hooks) of about [162;68]; [28 ;25]; [0 ;0] and [2 ;3] respectively for*

Swordfish, Black marlin, Striped marlin and Sailfish were obtained in 2010 against [137 ;71]; [8 ;11]; [9 ;13] and [2 ;2] in 2011. From these figures, we can infer that billfish do exist in the Madagascar water, it remains to prove this theory by assessing the abundance or biomass and ii) the primary sources of data that drive the expansion of CPUE are uncertain and should be investigated further."

42. **NOTING** that the longline fishery in Madagascar is a new and developing fishery, the WPB **RECOMMENDED** that Madagascar ensure that it develops and implements a data collection system, including sampling, logbooks and observers, which would adequately cover the entire fishery.

Maldives billfish landings

43. The WPB **NOTED** paper IOTC–2012–WPB10–12 which provided an overview of the Maldives billfish fishery, including the following abstract provided by the authors:

"*A small billfish fishery existed in Maldives for a long time. Fishermen have been selling their catch at the Malé fish market for local consumption for several decades. With the expansion of tourism industry in Maldives billfish fishermen found a new market to sell their catch and it also initiated big game fishing in Maldives. This resulted in higher exploitation of billfish in the Maldives. Today, due to reduction in tuna catches, a number of tuna fishermen from several islands are targeting billfish for their local consumption too. In addition, billfish are also caught by large yellowfin fishermen (bycatch) and longliners. Ministry of Fisheries and Agriculture (MOFA) has been keeping records of the billfish landings at Malé fish market which reached a peaked in 2006 at 950 tons but since then it has declined to about 530 tons in 2010. Billfish are exploited throughout Maldives but to date no proper records of landings have been maintained. Like any other fishery, where fish are landed at a number of ports, it has been a challenge for MOFA to obtain accurate catch statistics for the fishery."*

44. The WPB **NOTED** that the level of capture of marlins from the Maldivian artisanal fishery appears to be very high compared to the total catches reported for the Indian Ocean and **RECOMMENDED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting.

45. The WPB **RECOMMENDED** that the Maldives implement data collection systems, through logbooks and sampling for its fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

46. The WPB **AGREED** that although there are currently no sports fishery data collection programs in the Maldives, such programs would be highly beneficial given the rapidly expanding sports fishing industry operating in Maldivian waters.

I.R. Iran billfish landings

47. The WPB **NOTED** paper IOTC–2012–WPB10–13 which provided an overview of the I.R. Iran billfish fishery, including the following abstract provided by the authors:

"*Iran fishing grounds in southern waters of the country are located in the Persian Gulf and Oman Sea. There are 4 coastal provinces in those area with about 12000 vessels consist of fishing boat, dhows and vessel which are engaged in fishing in the coastal and non-coastal waters. Iran has well-established non-coastal water targeting tuna and like-Tuna species. The annual production of large pelagic in Iran was 412,000 t in 2011 and 183 000 tones belongs to tuna and tuna-like fishes in the Indian Ocean areas. Although there is no target fishery for Billfish, Iran makes considerable contribution to the Billfish production in the Indian Ocean. Billfishes make up to 3% 0f the total large pelagic landings in Iran that is for gillnet catch of Indian Ocean. Billfish production in Iran is at increasing trend during a period of 6 years i.e. from 2006 to 2011 shows a sustainable increase. Gillnet is the dominant gear in all areas. Majority of the production come from the Gillnet coastal and non-coastal waters. More Billfish's are caught as incidental catch in non-coastal waters targeting other species. In terms of area, more Billfishes are caught in northwestern areas. In coastal area there aren't any catch for Billfish. Length data are very poor for Billfish. Maximum recorded length for sailfish is 230cm (cut length).*"

48. The WPB **NOTED** that port samplers have not reported any swordfish, striped marlin or blue marlin in landings by Iranian vessels. The WPB **URGED** I.R. Iran to validate billfish species identification and to achieve this via the use of the billfish identification cards, soon to be printed by the IOTC Secretariat. Results of the validation should be presented at the next WPB meeting.

49. The WPB **NOTED** that the I.R. Iran has developed a pilot logbook project on board its gillnet fleet and is implementing training courses aimed at training fishers on how to collect data and fill out these logbooks, including the identification and reporting of bycatch and discarded species.

Mozambique billfish landings

50. The WPB **NOTED** paper IOTC–2012–WPB10–14 which provided an overview of the activities of fleets landing billfish in Mozambique waters, including the following abstract provided by the authors:

"*This report is based on swordfish production and on board data collected from foreign flagged vessels and since 2012 from a national flagged longliner. Data collected in Mozambican coast by the national longliner refers to fishing carried out mainly in Sofala Bank between 170 and 190 30. The catch composition was comprised mainly by shark followed by tuna, dolphinfish, marlin, sailfish and the remained percentage by other species. Swordfish size composition as a whole varied from 100 to 280 cm with two modes on 140 and 160 cm. The most abundant species in the three provinces namely Maputo, Inhambane and Sofala covered by game fish was kingfish. Black marlin was the most abundant species in Inhambane province. Black an d blue marlin were the species caught in the provinces covered by the artisanal data collection system from 2006 to 2010.*"

51. The WPB **ENCOURAGED** Mozambique to continue to report on its artisanal, sports and other recreational fisheries catches taken from Mozambique waters at the next WPB meeting.

52. The WPB **NOTED** non-clarity of the type of measurements currently used in Mozambique to collect length data. Supposed total length (TL) measurements reported to the WPB is not considered optimal. As such, the WPB **REQUESTED** that Mozambique collect lower jaw fork length (LJFL) and other standardised fish measurements instead of TL.

53. **NOTING** that at present no scientific observers are being placed on board foreign flagged vessels licenced to fish in the Mozambique EEZ, the WPB **RECOMMENDED** that Mozambique make it a licencing requirement for any foreign vessels fishing in the Mozambique EEZ to take on board scientific observers and to report the data collected as per IOTC requirements. Foreign vessels fishing in the Mozambique EEZ should ensure that scientific observers are brought onboard as per IOTC requirements.

Atlas of the longline fishery of La Reunion

54. The WPB **NOTED** paper IOTC–2012–WPB10–17 which provided an overview the Atlas of the drifting longline fishery of La Réunion island, Indian Ocean, including the following abstract provided by the authors:

"*In order to present to fishermen longline fishery data and to highlight them the usefulness of the collection of national fishery statistics and the need of good data quality, IFREMER from La Reunion decided under the IOSSS Project (http://wwz.ifremer.fr/lareunion/Les-projets/IOSSS-ESPADON), to elaborate an Atlas of the drifting longline fishery of La Réunion Island. This 245 pages book presents at the beginning*

- *a brief history of the Longline fishery in the Indian Ocean,*
- *the drifting longline fishing technic and concept*
- *the management of large pelagic fishes in the Indian Ocean*
- *the mains targeted species landed at La Réunion*
- *the national and international fisheries data collection system*

Then, the atlas presents series of maps at different scale describing:

(1) *The history of the total fishing effort and catches of swordfish by longline fleets operating in the Indian Ocean between 1950 and 2009. Fleets taken into account in these maps both target tropical tunas and swordfish.*
(2) *The history of the La Reunion longline fleet (greater than 10m) from 1993 to 2010. Effort, catches, CPUE by species, 5° or 1° statistical squares are shown by years and quarters*

Such atlas remains a powerful tool of communication and dissemination of scientific knowledge to professionals, and may be the most important, the return to fishermen of the statistical reporting obligations that was previously clearly lacking."

55. The WPB **NOTED** the effort made by La Réunion scientists to communicate and transfer information to local fishers on their catch and effort evolution and on the current management system of fishery statistics both at the national and international level.

Size distribution and length-weight relationships for marlins and spearfish in the Indian Ocean

56. The WPB **NOTED** paper IOTC–2012–WPB10–18 which provided size distribution and length-weight relationships for some billfish (marlins, spearfish and swordfish) in the Indian Ocean, including the following abstract provided by the authors:

"*Size frequencies and L-W relationships for two marlin species: blue marlin Makaira mazara, black marlin M. Indica, spearfish (striped marlin) Tetrapturus audax, and swordfish Xiphias gladius, caught during Soviet Indian Ocean Tuna Longline Research Programme (SIOTLLRP) in 1961-1989 are presented.*"

57. The WPB **AGREED** that the information on billfish meristics should be added to the biology tables in the species executive summaries and for the paper to be updated and presented at the next WPB meeting. The paper should document the relationships among the meristic measurements for the Indian Ocean and other oceans.

58. The WPB **REQUESTED** that more biological data is collected by CPCs in order to continue such studies, such as the measurement of standard and non-standard lengths, and weights, recorded by sex.

6.3. Review of new information on the status of marlins

6.3.1. Nominal and standardised CPUE indices

Japanese blue marlin and striped marlin CPUE analysis

59. The WPB **NOTED** paper IOTC–2012–WPB10–19 Rev_2 which provided a standardised CPUE for striped marlin and blue marlin based on Japanese longline catch and effort statistics from 1970 to 2010, including the following abstract provided by the authors:

"Log normal GLMs were applied to estimate STD CPUE for striped and blue marlin. Two GLM models are used, i.e., (1) BASE model (1971-2011) including effects of Y (year), Q (quarter), A (sub-area), G (gear: targeting), Miki+Eda (Materials of main and branch lines), IOI (Indian Ocean Oscillation Index), DMI (Indian Ocean Dipole Mode Index) and MP (Moon Phase) and (2) BASE+NCEP model (1980-2010) include additional effects of T45 (Sea temperature at 45m depth), SC (shear current) and TD (thermocline depth or mixed layer depth). All the ENV data (IOI, DMI, T45, Shear current, TD and IOI) except MP were examined if there were time-lag effects in 0-6 months to the nominal CPUE for these 2 species in advance. As a result, for striped marlin, it was found that there are 4 months-time lag effects in IOI and DMI, 1 month in TD and no time-lag effect (real time effect) in T45 and Shear current. As for blue marlin, 4 months in TD and no time lag effect in T45 and Shear current. – see paper for full abstract*)."*

60. The WPB **NOTED** that the analysis was comprehensive with regard to the addition of environmental covariates. The following items were noted to possibly improve the standardisation:
    i) the areas may not be spatially explicit as the catch rates are substantially different in some areas (e.g. south-west Indian Ocean);
    ii) gear changes may not be captured with the depth effect, though environmental interaction with shear current may explain this variation;
    iii) the delta-log-normal is probably a better model to use as the qq-plot indicates poor residual fits with the log-normal model with adding the constant;
    iv) presentation of the results should add parameter values with diagnostics indicating the direction of the main effects on the standardisation;
    v) it is not clear whether the changes in CPUE are confounded with directed/ undirected effort on the stocks prior to 1980.

61. The WPB **REQUESTED** that the analysis be conducted in a similar manner as the delta-log-normal model used in the Taiwan,China CPUE papers IOTC–2012–WPB10–20 Rev_1 and IOTC–2012–WPB10–21 Rev_1, for the next WPB meeting. This would allow comparison with the Taiwan,China CPUE standardisations, with the aim of developing a single data series for use in standardisation.

Taiwan,China blue marlin CPUE analysis

62. The WPB **NOTED** paper IOTC–2012–WPB10–20 Rev_1 which provided a CPUE standardisation of blue marlin (*Makaira nigricans*) caught by the Taiwan,China longline fishery in the Indian Ocean between 1980 to 2010, including the following abstract provided by the authors:

"Since blue marlin are bycatch species of Taiwanese longline fleet, large amount of zero catches are recorded from Taiwanese longline fleet. Therefore, this study attempts to the standardize CPUE of blue marlin caught by Taiwanese longline fleet in the Indian Ocean using delta-lognormal GLM

model. The results indicate that the area-specific standardized CPUE in the northern Indian Ocean (north of 10°S) reveal different trends with those in the southern Indian Ocean (south of 10°S). Standardized CPUEs in the northern Indian Ocean generally reveal decline trends during 1980 to 1990, increased during 1990 to 2000, and slightly decrease in recent years. However, Standardized CPUEs in the southern Indian Ocean increase during 1980 to 1995, fluctuated during 1995 to 2002, obviously decreased during 2003 to 2009, and substantially increased in 2010. The area-aggregated standardized CPUE of blue marlin in the Indian Ocean reveals four phases: sharply decreased during 1984-1990 when the catch began increasing; increased gradually during during1991-1999; decrease gradually during 2000-2007; CPUE obviously increased in recent years."

Taiwan,China striped marlin CPUE analysis

63. The WPB **NOTED** paper IOTC–2012–WPB10–21 Rev_1 which provided a CPUE standardisation of striped marlin (*Tetrapterus audax*) caught by the Taiwan,China longline fishery in the Indian Ocean between 1980 to 2010, including the following abstract provided by the authors:

"Since striped marlin are bycatch species of Taiwanese longline fleet, large amount of zero catches are recorded from Taiwanese longline fleet. Therefore, this study attempts to the standardize CPUE of striped marlin caught by Taiwanese longline fleet in the Indian Ocean using delta-lognormal GLM model. The results indicate that the area-specific standardized CPUE in the northern Indian Ocean (north of 10°S) reveal different trends with those in the southern Indian Ocean (south of 10°S). Standardized CPUEs in the northern Indian Ocean generally reveal decline trends during 1980s. The standardized CPUEs in the southern Indian Ocean generally reveal increasing trends during 1980 to 1995 and gradually decreased thereafter. In both of northern and southern Indian Oceans, the standardized CPUEs slightly increased in 2010. Although two CPUE peaks are observed in around 1985 and 1995, the area-aggregated standardized CPUE generally reveals a decline trend since 1980."

64. The WPB **AGREED** that the analysis undertaken was comprehensive and appropriate given the data available for analysis. However, the WPB suggested the following points for improving the CPUE analysis:
    - i) examine a finer resolution of areas if catches are not homogenous in the areas examined;
    - ii) provide parameter estimates or diagnostics indicating the direction of the main effects over time;
    - iii) add residual diagnostics of the model fits;
    - iv) examine exploratory analysis of the data before presenting the standardisation;
    - v) examine fishery effects (e.g. gear changes) that may be confounded with the effort changes over time.

65. The WPB **AGREED** that the recent data for the longline fleet of Taiwan,China, in particular for 2010, should be examined in detail to determine if the increased catches are a function of relocated effort into areas where striped marlin were not previously targeted, or an alternative reason.

66. The WPB **AGREED** that analysing the effect of weights on the separate areas provided in the assessment should be attempted for the next analysis. Results presented from different weights, primarily from catch, area, effort and CPUE indicated similar trends in the single Indian Ocean index.

67. The WPB **AGREED** that an ecologically area based assessment for different spatial resolution that mapped three areas should be undertaken, those areas being the Northern Indian ocean, Southern Indian ocean and coastal areas. Following further analysis using as a main effect at a 5x5 degree resolution, the results indicated a similar trend using these data as with the original area based approach.

68. **NOTING** that there were substantial uncertainties in catch, effort and fleet dynamics over time for the longline fleet from Taiwan,China, the WPB **AGREED** that in 2013, an exploratory analysis of the information should be undertaken which involved sensitivity analysis using indices that were thought to be optimistic and pessimistic.

Invited Expert review and CPUE analysis for marlins

69. The WPB **NOTED** paper IOTC–2012–WPB10–INF11 and INF12 which provided an exploratory analysis of the longline fisheries data, as well as CPUE analysis for black marlin, blue marlin and striped marlin, undertaken by the Invited Expert, Dr. Humber Andrade.

70. The WPB **AGREED** that the information papers were highly informative, as they explored in detail the catch and effort data by fleet, for discussion among the group, which subsequently guided the development

of preliminary stock assessments for blue marlin and striped marlin during the meeting. Such explanatory analysis is needed prior to any CPUE analysis in order to better identify and understand different patterns contained in the data that would help in the standardisation process.

71. The WPB **NOTED** that (1) for the Japanese longline fleet data, the proportion of zero catches increased through time, although the overall proportion of zero catches is not considered to be high except in the southern sections of the IOTC area of competence; (2) for the longline fleet of Taiwan,China, the areas with the highest proportion of zero catches, also in the southern areas of the IOTC area of competence, increased until 1980's but decreased until 2000's before stabilising.

Invited Expert review – Black marlin

72. The WPB **NOTED** that the catch rate estimates are still highly variable over time for both longline fleets from Japan and Taiwan,China and the similarity between both the longline datasets from Japan and Taiwan,China (Fig. 1).

73. The WPB **NOTED** that both catch rate time series (Japan and Taiwan,China) show a similar decreasing trend from 1960's until the end of 2000's. There is no available data for the longline fleet of Taiwan,China for the 1950's and part of the 1960's. Catch rates as calculated based on Japanese dataset show a strong decreasing trend in the early 1950's, in the very beginning of the commercial fisheries. Nevertheless it is important to highlight that the WPB have doubts on the reliability of the results based on aggregated data sets not fully reviewed by experts on Japanese longline fisheries. The WPB **AGREED** that the sharp decline between 1952 and 1958 in the Japanese black marlin CPUE series does not reflect the trend in abundance.

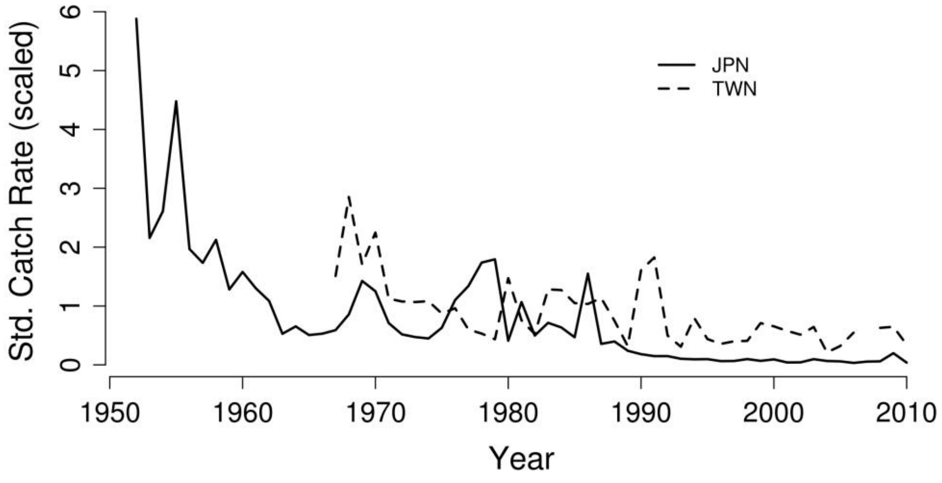


Fig. 1. Black marlin: Standardised catch rates of black marlin for Japan (JPN) and Taiwan,China (TWN) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Invited Expert review – Blue marlin

74. The WPB **AGREED** that the sharp decline between 1952 and 1956 in the Japanese blue marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1970 until 2011 is more likely to represent actual declines in stock abundance (Fig. 2).

75. The WPB **NOTED** that the catches and CPUE series estimated for blue marlin were very different between the longline fleets of Japan and Tawain,China. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

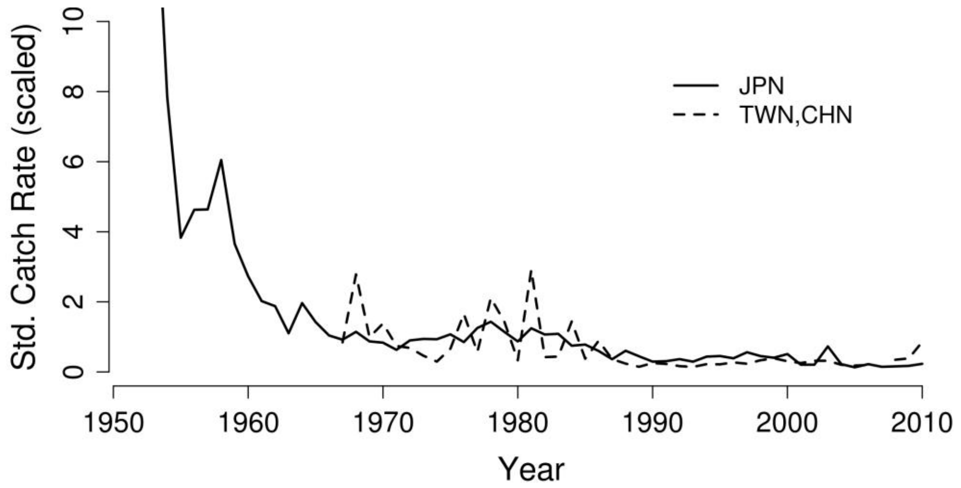


Fig. 2. Blue marlin: Standardised catch rates of blue marlin for Japan (JPN) (left plot) and Taiwan,China (TWN) (right plot) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

Invited Expert review – Striped marlin

76. The WPB **AGREED** that the sharp decline between 1952 and 1960 in the Japanese striped marlin CPUE series does not reflect the trend in abundance, although the gradual decline identified since 1960 until 2011 is more likely to represent actual declines in stock abundance (Fig. 3).

77. The WPB **NOTED** that the catches and CPUE series estimated for striped marlin were very different between the longline fleets of Japan and Taiwan,China. In particular the longline fleet data for Taiwan,China was highly variable and warranted further investigation and documentation.

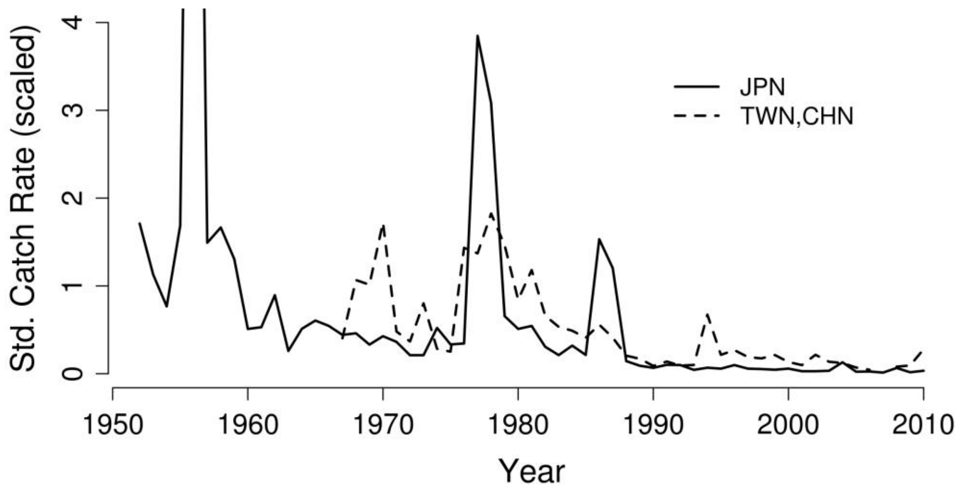


Fig. 3. Striped marlin: Standardised catch rates of striped marlin for Japan (JPN) (left plot) and Taiwan,China (TWN) (right plot) as calculated based on the IOTC catch and effort aggregated dataset. Values were scaled with respect to the mean of 1970–1979 period.

CPUE discussion summary – Marlins

78. The WPB **AGREED** that the following matters shall be taken into account when undertaking CPUE standardisation analysis in 2013:

Changes in targeting

79. The WPB **AGREED** that changes in species targeting is the most important issue to address in CPUE standardisations, and that the following points should be taken into consideration, when assessing bycatch data that is a function of differential targeting rates on other species:
    i. While hooks between floats (HBF) provides some indication of setting depth, it is generally considered not to be a sufficient indicator of species targeting. HBF is just one aspect of the setting technique, which can vary by species, area, set-time, and other factors.

ii. Highly aggregated (e.g. 5x5 degrees) data can make it difficult to observe the factors driving CPUE in a fishery, in particular the targeting effects. Operational data provides additional information that may allow effort to be classified according to fishing strategy (e.g. using cluster analyses or regression trees to estimate species targeting as a function of spatial areas, bait type, catch species composition, set-time, vessel-identity, skipper, etc.). Operational data would also permits vessel effects to be included in analyses.
iii. The inclusion of other species as factors in a Generalised Linear Model (GLM) standardisation may be misleading, because the abundance of all species changes over time. Including these factors may also fail to resolve problems due to changes in targeting, particularly when modeling aggregated data. However, comparing models with and without the other species factors can be useful to identify whether there is likely to be a targeting problem.

Spatial structure

80. The WPB **AGREED** that appropriate spatial structure needs to be considered carefully as fish density (and targeting practices) can be highly variable on a fine spatial scale, and it can be misleading to assume that large areas are homogenous when there are large shifts in the spatial distribution of effort. The following points should also be taken into consideration:
   i. Areas based on biological factors should be investigated for CPUE standardisation for future analysis.
   ii. Addition of finer scale (e.g. 1x1 degrees) fixed spatial effects in the model can help to account for heterogeneity within sub-regions.
   iii. Efforts should be made to identify spatial units that are relatively homogeneous in terms of the population and fishery to the extent possible (e.g. uniform catch size composition and targeting practices).
   iv. There may be advantages in conducting separate analyses for different sub-regions. The error distribution and proportion of zero sets may differ by sub-region, and there may be very different interactions among explanatory variables.
   v. There may be advantages in analyzing data of shorter temporal resolution with higher fishery specific covariates to assess if the longer term time-series is indicating the same temporal patterns.
   vi. The possibility of defining a representative ‘space-time’ window: if this leads to the identification of a fishery with homogeneous targeting practices, it is probably worthwhile. However, it may not be possible to identify an appropriate window, or the window may be so small that it is not representative of the larger population (or has a high variance).

81. **NOTING** that a set of ‘core areas’ which are likely to be robust to frequent fluctuations of external factors, may be more informative than using all of the data available, especially when other species are being targeted, the WPB **AGREED** to revisit the definitions of ‘core areas’ previously identified and agreed to by the WPB and used for CPUE standardisation to be presented at the next WPB in order to facilitate and monitor population abundance trends across all fleets. This should be carried out intersessionally and presented at the SC’s proposed longline CPUE workshop, to be held in the second quarter of 2013, and to the next WPB meeting.

Zero observations

82. The WPB **AGREED** that if there are many observations with positive effort and zero catch, it is worth considering models which explicitly model the processes that lead to the zero observations (e.g. negative binomial, zero-inflated or delta-lognormal models). Adding a small constant to the lognormal model may be fine if there are few zero’s, but may not be appropriate for areas with many zero catches (e.g. north of 10^{o}S). Sensitivity to the choice of constant should be tested as those might have substantial impacts on the stock assessment models.

Environmental variables

83. The WPB **NOTED** that the appropriate inclusion of environmental variables in CPUE standardisation is an ongoing research topic. Often these variables do not have as much explanatory power as, or may be confounded with, fixed spatial effects. This may indicate that model-derived environmental fields are not accurate enough at this time, or there may need to be careful consideration of the mechanisms of interaction to include the variable in the most informative way, in much the way that Japan analysed data with a particular time lag that describes biological mechanisms.

Model building

84. The WPB **AGREED** that it is difficult to prescribe analyses in advance, and model building should be undertaken as an iterative process to investigate the processes in the fishery that affect the relationship between CPUE and abundance. Specifically:
    i. Model building should proceed with a stepwise introduction of explanatory terms (or starting with a full model and removing one variable at a time), in which the net effect of each level of complexity is presented. Parameter estimates should be presented and examined to see if the mechanism makes sense and the contribution has a practical influence.
    ii. Simulations have shown that model selection using Akaike Information Criterion (AIC) tends to recommend over-parameterized models.

Review of fleet dynamics

85. The WPB **RECOMMENDED** that both Japan and Taiwan,China undertake a complete historical review of their longline data and to document the changes in fleet dynamics for presentation and the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

86. The WPB **AGREED** that there was merit in exploring the option of using all data from the two main fleets (Taiwan,China, and Japan) together in a combined CPUE analysis with a common area definition, to avoid missing combinations (area/quarter/other factors), by incorporating a "fleet effect". This may lead to a single standardised CPUE series which would avoid the need for CPUE series weighting, or examining alternative CPUE indices across different fleets.

Selection of CPUE series for stock assessments

87. The WPB **NOTED** that of the blue marlin CPUE series available for assessment purposes, listed below, the Japanese NCEP series should be used in the stock assessment model for 2012, for the reasons discussed above (shown in Fig. 4).
    - Japan data (1971–2011): Base series from document IOTC–2012–WPB10–19 Rev_2
    - Japan data (1980–2011): NCEP series from document IOTC–2012–WPB10–19 Rev_2
    - Taiwan,China data (1980–2010): Series from document IOTC–2012–WPB10–20 Rev_1

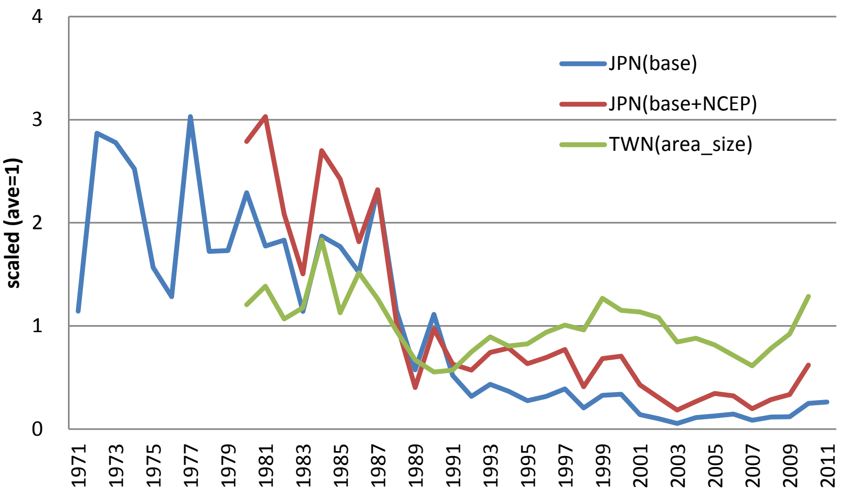


Fig. 4. Blue marlin: Comparison of the multiple CPUE series for longline fleets of Japan and Taiwan,China.

88. The WPB **NOTED** that of the striped marlin CPUE series available for assessment purposes, listed below, the Taiwan,China series should be used in the stock assessment model for 2012, for the reasons discussed above (shown in Fig. 5).
    - Japan data (1971–2011): Base series from document IOTC–2012–WPB10–19 Rev_2
    - Japan data (1981–2010): Base+NCEP series from document IOTC–2012–WPB10–19 Rev_2
    - Taiwan,China data (1980–2010): Series from document IOTC–2012–WPB10–21 Rev_1

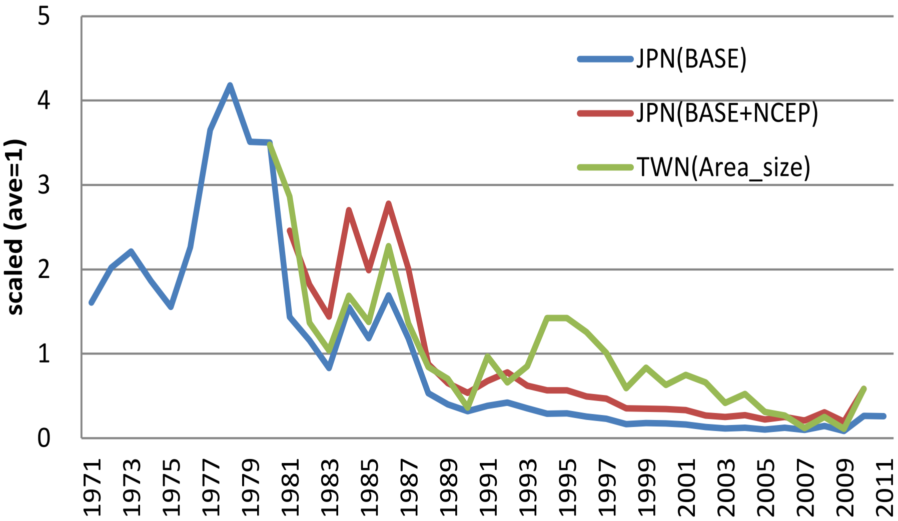


Fig. 5. Striped marlin: Comparison of the multiple CPUE series for longline fleets of Japan and Taiwan,China.

Parameters for future analyses: CPUE standardisation and stock assessments

89. The WPB **AGREED** that in order to obtain comparable CPUE standardisations, the analyses shall be conducted with similar parameters and resolutions in 2013, for presentation at the CPUE workshop agreed to by the SC. Table 2 provides a set of parameters, discussed during the WPB that shall give guidelines, if available, for the standardisation of CPUE in 2013 to be used as indices of abundance for the stock assessments.

Table 2. A set of parameters for the standardisation of CPUE series in 2013 for marlins.

CPUE standardisation parameters	Value for 2013 CPUE standardisation
Area	*To be defined (possibly use the North, South and Coastal Areas corresponding to Longhurst Areas for Indian Ocean)* Explore core area(s) as an alternative
CE Resolution	Operational data
GLM Factors	Year, Quarter, Area, HBF, vessel, environmental + interactions
Model	negative binomial, zero-inflated or delta-lognormal models

6.1.1 Stock assessments

90. The WPB **NOTED** that a range of quantitative modelling methods (ASPIC, Bayesian Production Model, and Surplus Production with catchability changes over decades) were applied to the blue marlin and striped marlin in 2012. The models were developed and run during the WPB10 meeting as a result of the increased level of expertise and time resources available during the meeting.

91. The WPB **AGREED** that because the models were developed during the WPB meeting, the '*Guidelines for the presentation of stock assessment models*', as agreed by the SC at its 13th session in 2010 would not necessarily be applied in full. However, the authors of the assessments, shall comply with the guidelines for all future assessments. The various assessments presented to the WPB in 2012 are summarised in the sections below.

Blue marlin: Summary of stock assessment models in 2012

92. The WPB **NOTED** Table 3 which provides an overview of the key features of each of the three stock assessments presented in 2012 (3 model types) for blue marlin, while Table 4 provides a summary of the assessment results.

93. The WPB **NOTED** the value of comparing different modelling approaches evaluating alternative hypothesis about the quality of the data used. Evaluating and validating the data is integral in the assessment, as fitting to alternative CPUE indices and assuming different catchability by period can have a large influence on the assessments.

94. The WPB **NOTED** that the assessments carried out in 2012 are preliminary and the results shown below were developed for exploratory and discussion purposes only.

Table 3. Blue marlin: Summary of final stock assessment model features as applied in 2012.

Model feature	**ASPIC**	**Bayesian production model**	**Surplus production model with varying catchability**
Software availability	NMFS toolbox	Coded	Coded
Population spatial structure / areas	1	1	1
Number CPUE Series	2	1	1
Uses Catch-at-length/age	No	No	No
Age-structured	No	No	No
Sex-structured	No	No	No
Number of Fleets	2	1	1
Stochastic Recruitment	No	No	No

Table 4. Blue marlin: Summary of model features for 2012.

Management quantity	ASPIC	Bayesian production model*	Surplus production model with varying catchability
Most recent catch estimate (t) (2010)	10,662		
Mean catch over last 5 years (t) (2006–2010)	9,247		
MSY (80% CI) [plausible range of values]	9,753 (8,341–13,510)	8.741 (4,887–10,903)	2,664 [n.a.]
Data period (catch)	1950–2010	1950–2010	1950–2010
CPUE series	Japanese + Taiwanese longline	Japanese longline	Japanese longline
CPUE period	1980–2010	1980–2010	1980–2010
$F_{current}/F_{MSY}$ (80% CI) [plausible range of values]	1.08 (0.73–1.65)	2.84 (0.98–6.79)	0.49 [n.a.]
$B_{current}/B_{MSY}$ (80% CI) [plausible range of values]	1.04 (0.69–1.34)	0.57 (0.27–1.02)	0.39 [n.a.]
SB_{2010}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.
SB_{2010}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.
B_{2010}/B_{1950} (80% CI)	0.48 (n.a.)	0.29 (n.a.)	0.19 [n.a.]
SB_{2010}/SB_{1950} (80% CI) [plausible range of values]	n.a.	n.a.	n.a
$SB_{2010}/SB_{current,\ F=0}$	n.a.	n.a.	n.a.

* All Bayesian production model credible intervals are 90%

Blue marlin: A Stock-Production Model Incorporating Covariates (ASPIC)

95. The WPB **AGREED** to provide the results of the ASPIC model based on the Japanese and Taiwanese longline data for illustrative purposes only. However, the WPB cautioned readers of this report that the information provided below is only for future comparison and not for the development of management advice.

96. The WPB **AGREED** that regardless of the preliminary nature and high uncertainty in the data set and methods used, the point estimates derived from all approaches described in Table 4 showed similar dynamics in terms of exploitation rates being higher than in the 1980's and 1990's with decreases in rates in recent years.

97. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below for blue marlin (Table 5; Fig. 6).

Table 5. Blue marlin: Key management quantities from the ASPIC assessment for Indian Ocean blue marlin.

Management Quantity	Indian Ocean
2010 catch estimate	10,662
Mean catch from 2006–2010	9,247
MSY (1000 t) (80% CI)	9,753 (8,341–13,510)
Data period used in assessment	1950–2010
F_{2010}/F_{MSY} (80% CI)	1.08 (0.73–1.65)
B_{2010}/B_{MSY} (80% CI)	1.04 (0.69–1.35)
SB_{2010}/SB_{MSY}	–
B_{2010}/B_{1950} (80% CI)	0.48 (n.a.)
SB_{2010}/SB_{1950}	–
$B_{2010}/B_{1950, F=0}$	–
$SB_{2010}/SB_{1950, F=0}$	–

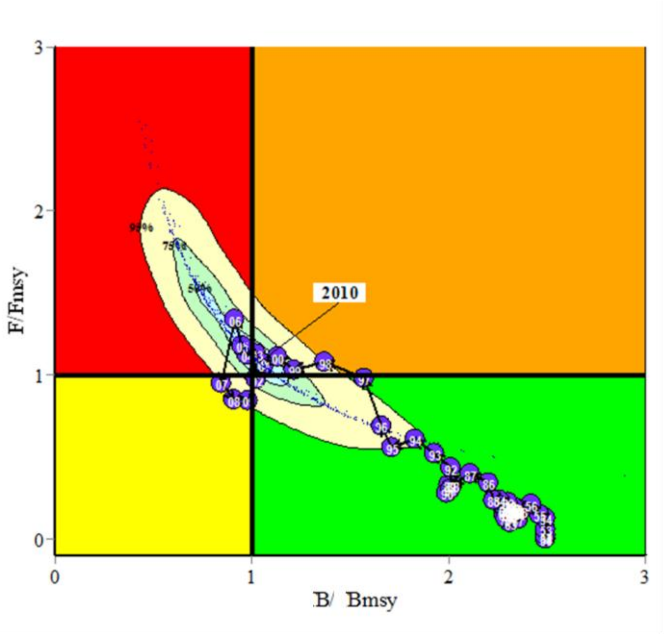


Fig. 6. Blue marlin: ASPIC Aggregated Indian Ocean assessment Kobe plot for blue marlin (95% bootstrap confidence surfaces shown around 2010 estimate). Blue circles indicate the trajectory of the point estimates for the biomass (B) ratio and F ratio for each year 1950–2010.

Striped marlin: Summary of stock assessment models in 2012

98. The WPB **NOTED** Table 6 which provides an overview of the key features of each of the four stock assessments presented in 2012 (3 model types) for striped marlin, while Table 7 provides a summary of the assessment results.

99. The WPB **NOTED** the value of comparing different modelling approaches evaluating alternative hypothesis about the quality of the data used. Evaluating and validating the data is integral in the assessment, as fitting to alternative CPUE indices and assuming different catchability by period can have a large influence on the assessments.

100. The WPB **NOTED** that the assessments carried out in 2012 are preliminary and the results shown below were developed for exploratory and discussion purposes only.

Table 6. Striped marlin: Summary of final stock assessment model features as applied to striped marlin in 2012.

Model feature	**ASPIC**	**Bayesian production model**	**Surplus production model with varying catchability**
Software availability	NMFS toolbox	Coded	Coded
Population spatial structure / areas	1	1	1
Number CPUE Series	1	1	1
Uses Catch-at-length/age	No	No	No
Age-structured	No	No	No
Sex-structured	No	No	No
Number of Fleets	2	1	1
Stochastic Recruitment	No	No	No

Table 7. Striped marlin: Summary of model features for 2012.

Management quantity	ASPIC (Run 1)	ASPIC (Run 2)	Bayesian production model*	Surplus production model with varying catchability
Most recent catch estimate (t) (2010)	2,529			
Mean catch over last 5 years (t) (2006–2010)	2,092			
MSY (80% CI) [plausible range of values]	3,503 (3,216–5,262)	3,275 (3,199–4,310)	2,240 (1,034–3,635)	4,422 [n.a.]
Data period (catch)	1980–2010	1980–2010	1950–2010	1950–2010
CPUE series	Japanese longline	Taiwan,China longline	Taiwan,China longline	Taiwan,China longline
CPUE period	1980–2010	1980–2010	1980–2010	1980–2010
$F_{current}/F_{MSY}$ (80% CI) [plausible range of values]	3.49 (1.44–6.33)	0.64 (0.55–1.22)	5.98 (2.32–12)	0.32 [n.a.]
$B_{current}/B_{MSY}$ (80% CI) [plausible range of values]	0.19 (0.04–0.35)	1.05 (0.50–1.14)	0.18 (0.11–0.28)	0.9 [n.a.]
SB_{2010}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.	n.a.
SB_{2010}/SB_{MSY} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.	n.a.
B_{2010}/B_{1950} (80% CI)	B_{2010}/B_{1980} 0.10 (n.a.)	B_{2010}/B_{1980} 0.15 (n.a.)	n.a.	0.45 [n.a.]
SB_{2010}/SB_{1950} (80% CI) [plausible range of values]	n.a.	n.a.	n.a.	n.a.
$SB_{2010}/SB_{current, F=0}$	n.a.	n.a.	n.a.	n.a.

* All Bayesian production models credible intervals are 90%

A Stock-Production Model Incorporating Covariates (ASPIC) for striped marlin

101. The WPB **AGREED** to provide the results of the ASPIC model based on the Japanese longline data and the Taiwan,China longline to illustrate the range of uncertainty. However, the WPB cautioned readers of this report that the information provided below is only for future comparison and not for the development of management advice.

102. The WPB **AGREED** that regardless of the preliminary nature and high uncertainty in the data set and methods used, the point estimates derived from all approaches described in Table 7 showed similar dynamics in terms of exploitation rates being higher than in the 1980's and 1990's with decreases in rates in recent years.

103. The WPB **NOTED** the key assessment results for A Stock-Production Model Incorporating Covariates (ASPIC) as shown below for striped marlin (Table 8; Fig. 7).

104. The WPB **NOTED** that the catch data used in assessments in 2012 contained unexplained peaks and trends that made it difficult for the model to capture the variation over time. Hence, the use of model with changing catchability was used as a basis.

Table 8 Striped marlin: Key management quantities from two ASPIC assessment runs, for the Indian Ocean striped marlin. Runs refer to those shown in Table 7.

Management Quantity	ASPIC (Run 1)	ASPIC (Run 2)
2010 catch estimate	2,529	
Mean catch from 2006–2010	2,090	
MSY (1000 t) (80% CI)	3,003 (3,216–5,262)	3,275 (3,199–4,310)
Data period used in assessment	1980–2010	1980–2010
F_{2010}/F_{MSY} (80% CI)	3.49 (1.44–6.33)	0.64 (0.55–1.22)
B_{2010}/B_{MSY} (80% CI)	0.19 (0.04–0.35)	1.05 (0.50–1.14)
SB_{2010}/SB_{MSY}	–	–
B_{2010}/B_{1980} (80% CI)	0.10 (n.a.)	0.15 (n.a.)
SB_{2010}/SB_{1980}	–	–
$B_{2010}/B_{1980,\ F=0}$	–	–
$SB_{2010}/SB_{1980,\ F=0}$	–	–

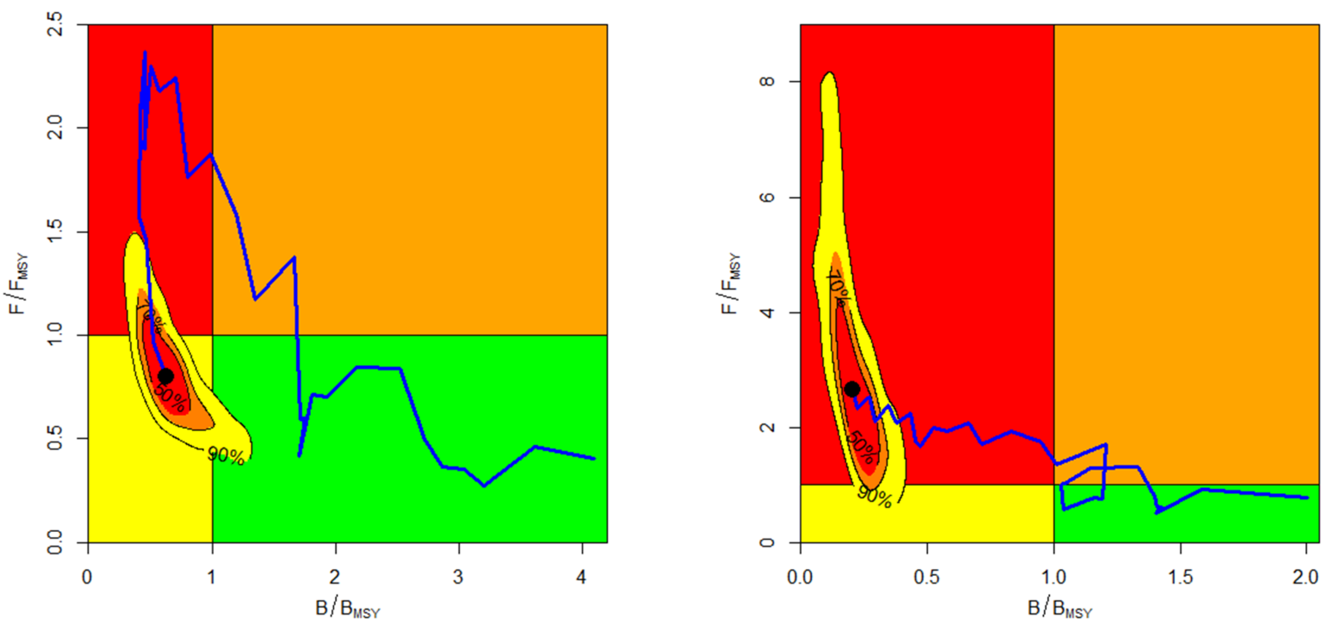


Fig. 7. Striped marlin: ASPIC Aggregated Indian Ocean assessment Kobe plots for striped marlin (95% bootstrap confidence surfaces shown around 2010 estimate – black dot). Blue circles indicate the trajectory of the point estimates for the total biomass (B) ratio and F ratio for each year 1950–2010. The left plot is based on the Japanese CPUE series only, while the right plot is based on the Taiwan,China CPUE series only.

Parameters for future analyses: stock assessments

105. **NOTING** that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses, and this could have a detrimental effect on the quality of advice provided by the WPB, the WPB **RECOMMENDED** that exchanges of data (CPUE indices and coefficient of variation) should be made as early as possible, but no later than 30 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 15 days before a working party meeting, as per the recommendations of the SC, which states: "*The SC also ENCOURAGED data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs*

and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and RECOMMENDED that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs." (IOTC–2011–SC14–R; p68)

106. The WPB **AGREED** that alternative approaches should be explored using the following in 2013:
   - More effort should be made in examining the standardised CPUE data for use in the assessments as these are the basis for assessments without any age/length data available.
   - Age/Length data over time should be collected so that alternative approaches could be examined.
   - Examining whether a constant or variable catchability (q) is dependent on how well the CPUE is standardised. If the standardisation does not account for the changes, then using variable catchabilities should occur in the assessment.
   - Finer spatial resolution and fisheries structure should probably be taken into account in the assessment.

6.3.2. Selection of Stock Status indicators for marlins

107. The WPB **NOTED** that the assessments carried out in 2012 are preliminary and the results were developed for exploratory and discussion purposes only.

108. The WPB **AGREED** that stock status should be determined by qualitatively integrating the results of the various stock assessments undertaken in 2012 with other status indicators for each marlin species. The WPB treated all analyses as equally informative, and focussed on the features common to all of the results.

109. In deciding upon the most appropriate way to present the integrated stock assessment results to the SC, the WPB **AGREED** that none of the species model results should be depicted in the species executive summaries.

6.4. Development of management advice for marlins

110. The WPB **RECOMMENDED** that the SC note the management advice developed for marlins as provided in the draft resource stock status summaries:
   - Black marlin (*Makaira indica*) – Appendix VII
   - Blue marlin (*Makaira nigricans*) – Appendix VIII
   - Striped marlin (*Tetrapterus audax*) – Appendix IX

6.5. Update of marlin species Executive Summaries for the consideration of the Scientific Committee

111. The WPB **REQUESTED** that the IOTC Secretariat update the draft stock status summaries for the marlin species with the latest 2011 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

7. INDO-PACIFIC SAILFISH

7.1. Review of data available at the secretariat for Indo-Pacific sailfish

112. The WPB **NOTED** paper IOTC–2012–WPB10–07 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for sailfish, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2010. Statistics for 2011 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October). The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching sailfish in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, and size-frequency. A summary of the supporting information for the WPB is provided in Appendix V.

113. The WPB **NOTED** the main sailfish data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI, and **REQUESTED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

7.2. Review of new information on the biology, stock structure, fisheries and associated environmental data

114. **NOTING** that limited new information on I.P. sailfish were presented at the WPB10, the WPB **REQUESTED** that the IOTC Secretariat contact scientists from the U.A.E. to obtain the latest information from the sailfish

fishery in the Gulf, as the most recent information submitted to the WPB some time ago suggested that the fishery may be collapsing. Any new information received should be submitted to the next WPB meeting.

115. The WPB **NOTED** paper IOTC–2012–WPB10–INF11 which provided an exploratory analysis of the longline fisheries data, as well as CPUE analysis for Indo-Pacific sailfish, undertaken by the Invited Expert, Dr. Humber Andrade.

7.3. Review of new information on the status of Indo-Pacific sailfish

7.3.1. Nominal and standardised CPUE indices

116. The WPB **NOTED** that currently there is insufficient data to develop a CPUE series for Indo-Pacific sailfish caught in the IOTC area of competence.

7.3.2. Stock assessments

117. The WPB **AGREED** that although no stock assessment was undertaken for sailfish caught in IOTC fisheries in 2012, further exploratory analysis of the data available should be undertaken in preparation for the next WPB meeting.

7.3.3. Selection of Stock Status indicators for Indo-Pacific sailfish

118. The WPB **AGREED** that there are limited stock status indicators available for Indo-Pacific sailfish and further work is urgently required in 2013.

7.4. Development of management advice for Indo-Pacific sailfish

119. The WPB **RECOMMENDED** that the SC note the management advice developed for Indo-Pacific sailfish (*Istiophorus platypterus*), as provided in the draft resource stock status summary (Appendix X).

7.5. Update of sailfish species Executive Summaries for the consideration of the Scientific Committee

120. The WPB **REQUESTED** that the IOTC Secretariat update the draft stock status summary for sailfish with the latest 2011 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

8. SWORDFISH

8.1. Review of data available at the secretariat for swordfish

121. The WPB **NOTED** paper IOTC–2012–WPB10–07 which summarised the standing of a range of data and statistics received by the IOTC Secretariat for swordfish, in accordance with IOTC Resolution 10/02 *Mandatory statistical requirements for IOTC Members and Cooperating non-Contracting Parties (CPC's)*, for the period 1950–2010. Statistics for 2011 were not covered in the paper as preliminary catches for the previous year are usually reported later during the following year (June–October). The paper also provided a range of fishery indicators, including catch and effort trends, for fisheries catching swordfish in the IOTC area of competence. It covers data on nominal catches, catch-and-effort, and size-frequency. A summary of the supporting information for the WPB is provided in Appendix V.

122. The WPB **NOTED** the main swordfish data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI, and **REQUESTED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

8.2. Review of new information on the biology, stock structure, fisheries and associated environmental data

Indian Ocean Swordfish horizontal and vertical movements

123. The WPB **NOTED** paper IOTC–2012–WPB010–16 which provided the results of a study on the horizontal and vertical movements of swordfish tagged with pop-up satellite transmitters in the south-west Indian Ocean, off South Africa, including the following abstract provided by the authors:

"*Eleven longline-caught swordfishes were tagged with pop-up satellite (PSAT) tags off the coast of South Africa. Although post-release mortality rates were high, four fishes (36%) yielded datasets longer than two months. Fish condition on visual assessment or duration hooked on the longline was a poor indicator of release success. All four swordfish undertook periodical diel diving behaviour, but one fish dived mainly at* *night. Basking behaviour was not observed as all fishes stayed below 8 m of water depth. Bathymetry and moon phase did not seem to influence diving depth, but dives seemed to be restricted by a temperature ceiling of ca. 8°C. Maximum and minimum water temperature encountered by the fish generally matched those found in other studies around the world. Diving patterns did not change with average swimming speed, but longer presence in shallow waters during faster swimming was observed in one fish. All swordfishes remained within the region but one fish crossed the 20 deg longitude boundary twice indicating that there might be a link to the Southern Atlantic stock. Swordfish horizontal movement showed no clear link with bathymetry or chlorophyll-a, but two fishes seemed to trace the edge of meso-scale eddies.*"

124. The WPB **NOTED** that the preliminary analyses of data of the first PSAT tagged swordfish off South Africa revealed vertical movement patterns that are mostly consistent with studies elsewhere in the world, although there were some differences, namely the absence of basking behaviour, the inconsistent relationship of diving pattern with moon phase and the reverse diving pattern displayed by one of the animals.

125. The WPB **NOTED** that swordfish dives seemed to be restricted by a temperature ceiling at depth and a significantly higher percentage of time was spent in shallow > 400m waters. This ongoing study, developed under the SWIOFP, aims to investigate the residency of swordfish in the southwest Indian Ocean, and the WPB **ENCOURAGED** the continuation of this project.

Indian Ocean Swordfish Stock Structure project (IOSSS)

126. The WPB **NOTED** paper IOTC–2012–WPB10–15 which provided the results of the Indian Ocean swordfish stock structure (IOSSS) project, including the following abstract provided by the authors:

"*Genetic population structure of swordfish Xiphias gladius was examined among three major sampling areas within the Indian Ocean (twelve sites), Atlantic (two sites) and Pacific (one site) Oceans using analysis of nineteen microsatellite loci and mitochondrial ND2 sequence data. Sample collection was stratified in time and space in order to investigate the stability of the genetic structure observed with a special focus on the South West Indian Ocean. Significant AMOVA variance was observed for both markers indicating genetic population subdivision was present between oceans. Overall value of F-statistics for ND2 sequences confirmed that Atlantic and Indian Ocean swordfish represent two distinct genetics stocks. Indo-Pacific differentiation was also significant but differentiation between these two oceans was less than that observe between Atlantic and Indian Oceans. However, microsatellite F-statistics failed to reveal clear level of structure even at the inter-oceanic scale, indicating that resolving power of our microsatellite loci was insufficient for detecting population subdivision. At the scale of the Indian Ocean, results obtained from both markers are consistent with the swordfish of the IO belonging to a single unique panmictic population or at least several breeding grounds with significant exchange of genetic material. Partitioning of analysis, by sampling areas, seasons, or by sex failed to identify any clear structure within this ocean. Such spatial and temporal homogeneity on genetic structure of the large pelagic swordfish confirms that the current management of swordfish as a single stock in the Indian Ocean is in agreement with our findings.*"

127. The WPB **RECOMMENDED** that the SC note that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision.

8.3. Review of new information on the status of swordfish

8.3.1. Nominal and standardised CPUE indices

European Union longline fisheries

128. The WPB **NOTED** paper IOTC–2012–WPB10–11 which described the historical activities of the Portuguese longline fishery operating in the Indian Ocean since the late 1990's, and a standardised CPUE analysis, including the following abstract provided by the authors:

"*The Portuguese longline fishery targeting swordfish in the Indian Ocean started in the late 1990's. This fishery targets mainly swordfish, but also bycatches pelagic sharks such as blue shark and shortfin mako. A recent effort by Portuguese Marine and Atmosphere Institute (IPMA) has been made aiming the collection of historical catch data on this fishery since the late 1990's to the present date. This working document reports an overview of the Portuguese swordfish fishery, including analyses on the catches, effort, catch-at-size and CPUE trends. The trends in the swordfish catch-at-size were analyzed annually,* *and compared between months and regions of operation of the fishery. Nominal annual CPUEs were calculated as Kg/1000 hooks, and were standardized with Generalized Linear Models (GLMs) using year, quarter, location and swordfish/blue shark ratio as explanatory variables. Three different modeling approaches were used and compared, including tweedie, gamma and lognormal models, and model validation was carried out with a residual analysis. The results presented in this working document provide the first preliminary trends and analysis on swordfish catches available for the Portuguese longline fishery operating in the Indian Ocean.*"

129. The WPB **NOTED** that there are other possible targeting factor options besides the ratio of SWO/SWO+BSH used.

130. The WPB **RECOMMENDED** that scientists from EU,Portugal and EU,Spain undertake a revised CPUE analysis for their longline fleets, and consider combining the analysis prior to the next WPB meeting where swordfish will be dealt with as a priority.

CPUE Summary discussion (from the previous WP meeting – WPB09)

131. The WPB **NOTED** the following regarding the state of CPUE analysis for fleets targeting swordfish in the IOTC area of competence:
   - Uncertainty remains about the appropriate spatial units for the CPUE standardisation. These issues should be reconsidered prior to the next stock assessment for swordfish is undertaken.
   - Trends in standardised CPUE differ considerably among fleets that operate in the same area (notably southwest region in recent years), and efforts should be made to understand why.
   - The steep decline in Japanese CPUE in the southwest region in the early 1990s may exaggerate the perception of population decline because it occurs during a period of rapidly changing main line material (and the number of Hooks Between Floats), and the timing of the decline is sensitive to spatial assumptions.
   - The spatial distribution of effort has changed substantially for all of the main longline fleets, and the analysis needs to account for spatial heterogeneity within the large standardisation regions.
   - Target species are known to have changed substantially for the Japanese and Taiwan,China fleets, and it is unclear if the available data and methods can account for these changes.
   - The effects of some oceanographic variability on the species distribution and catchability are not well understood. Environmental covariates may be confounded with fixed spatial and temporal effects, they could be describing important interannual variability in catchability (which would improve the series), or they could be spuriously correlated with fish abundance (in which case their use could be counter-productive). Until these mechanisms are better understood, it is worth running models with and without environmental covariates.
   - Standard statistical model selection criteria have been shown to prefer over-parameterised models in simulation studies.

132. The WPB **NOTED** the following CPUE series from the 2012 and previous WPB meetings:
   - Japan data (1980–2009): Series 3.2 from document IOTC–2011–WPB09–14, which includes fixed latitude and longitude effects, plus environmental effects.
   - Taiwan,China data (1995–2009): Model 10 from document IOTC–2011–WPB09–23, which includes fixed latitude and longitude effects, plus environmental effects.
   - EU,Portugal data (1999–2011): IOTC–2012–WPB10–11, which includes major areas, seasonal effects and species ratio factors.
   - EU,Spain data (2001–2009): Series 5 from document IOTC–2011–WPB09–23, calculated for the southwest area only (includes sub-region factors and species ratio factors) area and run 1 for the assessment of whole Indian Ocean.
   - EU,La Reunion data (1994–2000): Same series as last year (IOTC–2010–WPB09–03).

133. The WPB **NOTED** the CPUE series used in the stock assessment models for 2011 (shown in Figs. 8 and 9).

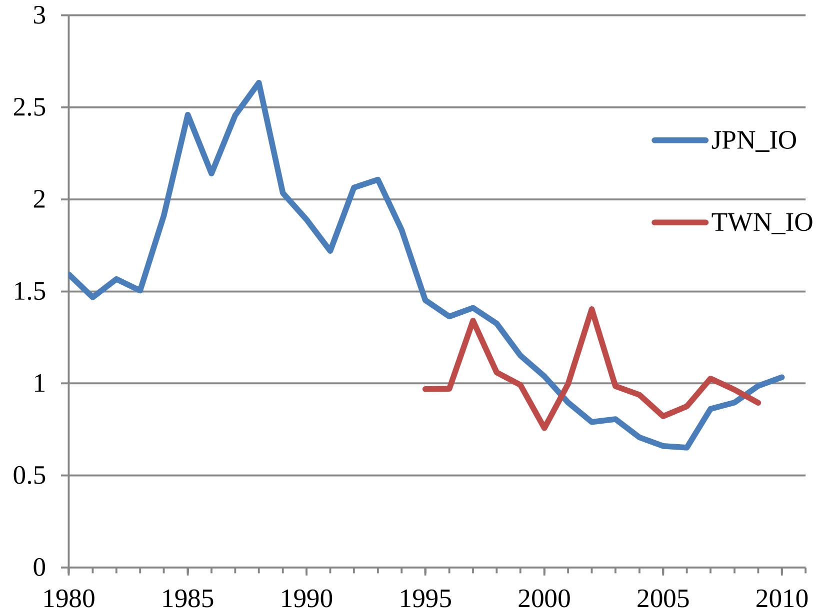


Fig. 8. Swordfish: Recommended CPUE series for Indian Ocean swordfish. Series have been rescaled relative to their respective means from 1980–2010.

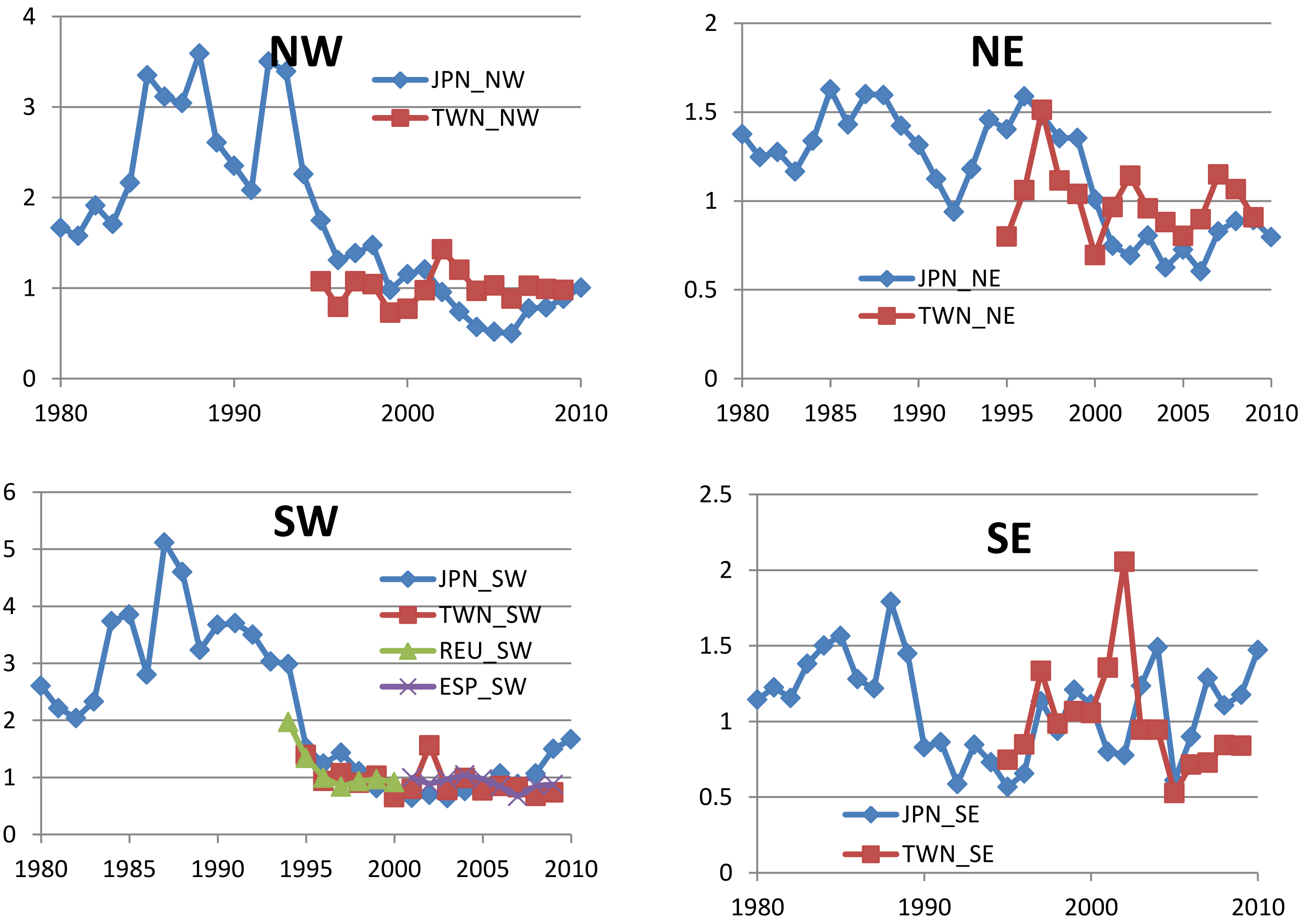


Fig. 9. Swordfish: CPUE series for Indian Ocean swordfish assessments in 2011 by sub-region. Series have been rescaled relative to their respective means (for different overlapping time periods). NW – north-west; SW – south-west; NE – north-east; SE – south-east Indian Ocean.

8.3.2. Stock assessments

134. The WPB **NOTED** that no stock assessment was undertaken for Indian Ocean swordfish in 2012. When considering whether a new stock assessment should be undertaken for the aggregate Indian Ocean and the south-west Indian Ocean in 2013, the WPB considered that unless new relevant information was likely to be presented, in particular a fine scale CPUE analysis for the EU,Spain and EU,France longline fisheries, then there was no point in revising the assessments. However, the WPB **AGREED** that a new stock assessment be presented at the 2014 WPB at the latest, providing that fleets that have and are targeting swordfish (e.g. European Union fleets, Australia and others) present new or revised standardised CPUE series.

8.3.3. Selection of Stock Status indicators for swordfish

135. The WPB **NOTED** that the stock structure of the Indian Ocean swordfish resource remains under investigation, but currently uncertain. The southwest region was identified as a management unit of particular concern, because it seems to be more depleted than other regions in the Indian Ocean, and may have limited mixing with other regions.

136. The WPB **NOTED** the range of quantitative modelling methods were applied to the swordfish assessment in 2011, ranging from the highly aggregated ASPIC surplus production model to the age-, sex- and spatially-structured SS3 analysis. The different assessments were presented to the WPB in documents IOTC–2011–WPB09–17, 18, 19 and 20. Each model is summarised in the report of the Ninth Session of the WPB (IOTC–2011–WPB09–R) and are not presented here for brevity.

137. The WPB **NOTED** the value of comparing different modelling approaches. The structured models are capable of a more detailed representation of complicated population and fishery dynamics, and integrate several sources of data and biological research that cannot be considered in the simple production models. However, there are a lot of uncertainties in basic swordfish biology (e.g. growth rates, M, stock recruitment relationship), and it is difficult to represent all of these uncertainties. In contrast, the production models often provide robust estimates regardless of uncertainties in basic biological characteristics. However, sometimes the ASPIC model can have difficulty fitting long time series, and production models in general cannot represent some important dynamics (e.g. arising from complicated recruitment variability).

138. The WPB **AGREED** that swordfish stock status should be determined by qualitatively integrating the results of the various stock assessments undertaken in 2011. The WPB treated all analyses as equally informative, and focussed on the features common to all of the results, as well as the latest catch and effort trends.

8.4. Development of management advice for swordfish

139. The WPB **RECOMMENDED** that the SC note the management advice developed for swordfish (*Xiphias gladius*), as provided in the draft resource stock status summary (Appendix XI).

8.5. Update of swordfish Executive Summaries for the consideration of the Scientific Committee

140. The WPB **REQUESTED** that the IOTC Secretariat update the draft stock status summaries for swordfish with the latest 2011 catch data, and for the summary to be provided to the SC as part of the draft Executive Summary, for its consideration.

9. EFFECT OF PIRACY ON BILLFISH FISHERIES

141. The WPB **NOTED** that, although no specific analysis of the impacts of piracy on fisheries in the Indian Ocean were presented at this meeting, paper IOTC–2012–WPB10–07 indicated that there has been a substantial displacement of effort eastward (Fig. 10). Since 2004, annual catches have declined steadily, largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean (Fig. 11). In recent years, the proportion of fishing effort of the Japanese longline fleet sharply decreased in the north-western Indian Ocean (off the Somalia coastline), while fishing effort increased in the area south of 25°S, especially off western Australia.

142. The WPB **NOTED** that the number of active vessels in the IOTC area of competence have declined substantially since 2008 (Fig. 11), and **AGREED** that this was likely due to the impact of piracy activities in the western Indian Ocean.

143. The WPB **RECOMMENDED** that given the potential impacts of piracy on billfish fisheries, specific analysis should be carried out and presented at the next WPB meeting by the CPCs most affected by these activities, including Japan, Rep. of Korea and Taiwan,China.

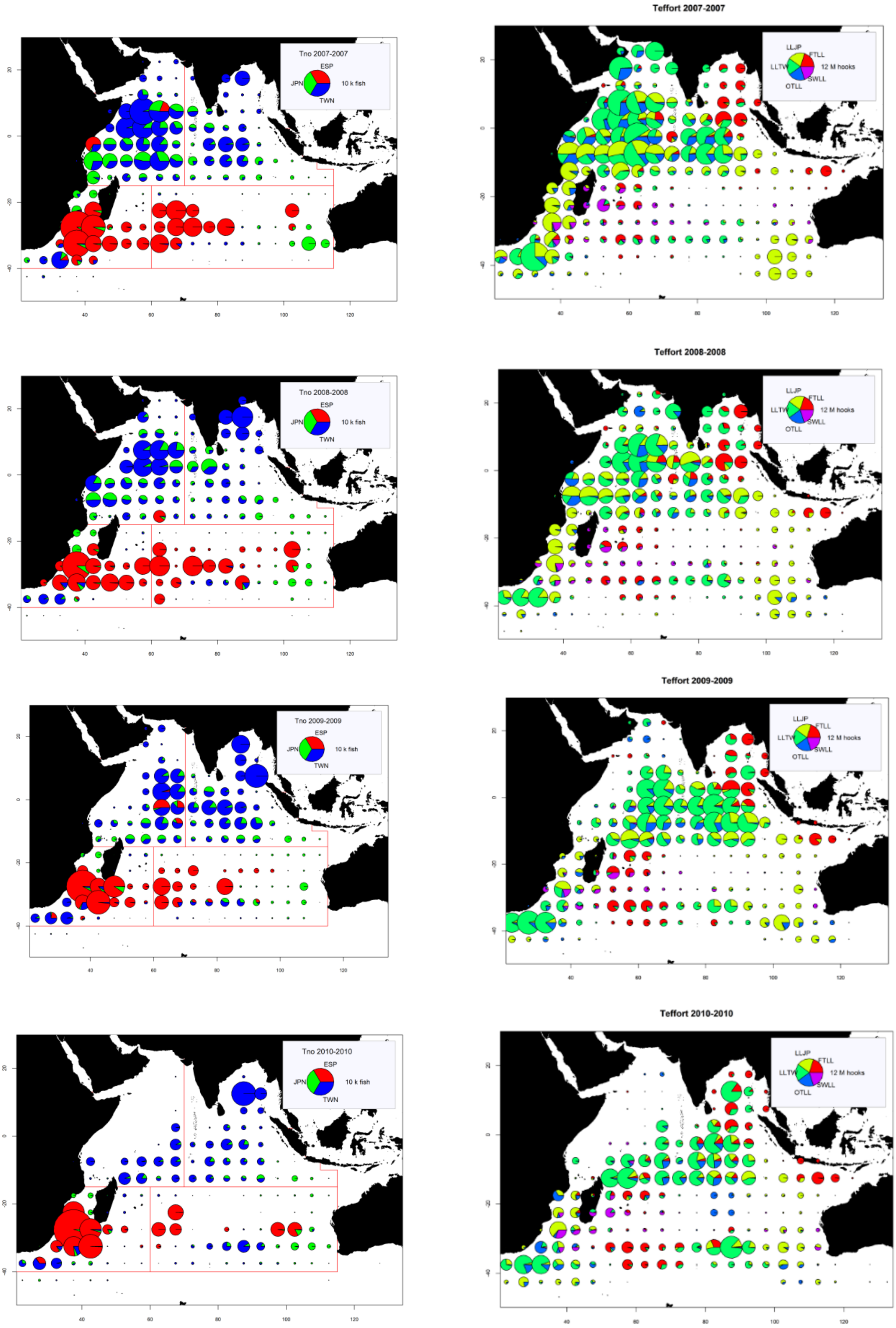


Fig. 10. The geographical distribution of swordfish catches (tonnes) as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU,Spain (ESP), the latter directed at swordfish (left column), and by gear and effort by the main longline fleets (millions of hooks; right column) caught in the IOTC area of competence, 2007–10. Red lines represent the boundaries of the areas used for the assessments of swordfish. Catch: Japanese longline (green), EU,Spain longline (red), Taiwan,China longline (blue). Effort: LLJP

(light green): deep-freezing longliners from Japan; LLTW (dark green): deep-freezing longliners from Taiwan,China; SWLL (turquoise): swordfish longliners (Australia, EU, Mauritius, Seychelles and other fleets); FTLL (red) : fresh-tuna longliners (China, Taiwan,China and other fleets; OTLL (blue): Longliners from other fleets (includes Belize, China, Philippines, Seychelles, South Africa, South Korea and various other fleets).

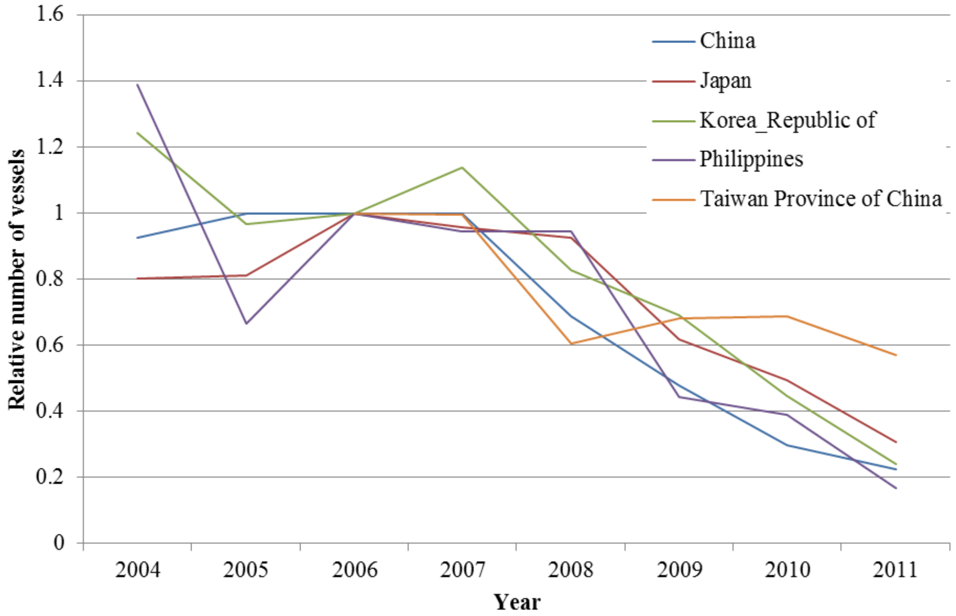


Fig. 11. The change in the relative number of active longline vessels for some fleets in the Indian Ocean since 2004 (Numbers have been scaled to the number of active vessels in 2006).

10. Research Recommendations and Priorities

Revision of the WPB workplan

144. The WPB **AGREED** that there was no urgent need to carry out stock assessments for the swordfish resources in the Indian Ocean in 2013, and therefore that efforts over the coming year be focused on the other billfish species, in particular on striped marlin, blue marlin and black marlin.

145. The WPB **RECOMMENDED** that the Istiophorids (striped marlin, blue marlin, black marlin and Indo-Pacific sailfish) undergo new or revised CPUE analysis in 2013, taking into account the various points in the CPUE discussion summaries throughout this report).

146. The WPB **RECOMMENDED** the following core areas as priorities for research over the coming year;
    - Billfish species biology (i.e. growth reproduction)
    - Size data analyses
    - Stock status indicators – exploration of indicators from the available data
    - Striped marlin, blue marlin and black marlin CPUE standardisation
    - Stock assessment – Istiophorids

11. Other Business

11.1. Risk-based approaches to determining stock status

147. The WPB **NOTED** that a Weight-of-Evidence approach is currently being used in a number of countries to routinely determine stock status for data poor fisheries. The approach involves developing and applying a decision-making framework by assembling an evidentiary base to support status determination. Specifically, the framework aims to provide a structured, scientific process for the assembly and review of indicators of biomass status and levels of fishing mortality. Arguments for status determination are based upon layers of partial evidence. Ideally there would be independence between these layers which will be developed with a mixture of quantitative and qualitative reasoning. The framework provides guidance with which to interpret those indicators, and aims to provide a transparent and repeatable process for status determination. The framework

includes elements to describe attributes of the stock and fishery; documentation of lines of evidence; and documentation of status determination.

148. The WPB **NOTED** that for billfish stocks (with the exception of swordfish), particularly in smaller fisheries, only a subset of the types of evidence are likely to be available and/or useful. As a result, expert judgment has an important role in status determination, with an emphasis on documenting the key evidence and rationale for the decision.

149. The WPB **RECOMMENDED** that the IOTC Secretariat facilitate a process to provide the necessary information to the SC so that it may consider the Weight-of-Evidence approach to determine species stock status, as an addition to the current approach of relying solely on fully quantitative stock assessment techniques.

11.2. Development of priorities for an Invited Expert at the next WPB meeting

150. The WPB **NOTED** with thanks, the outstanding contributions of the invited expert for the meeting, Dr. Humber Andrade from the Universidade Federal Rural de Pernambuco in Brazil. Dr. Andrade work, both prior to and during the WPB meeting contributed greatly to the groups understanding of billfish data and assessment methods.

151. The WPB **AGREED** to the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPB in 2013:
    - Expertise: experience with CPUE analysis for marlins and/or sailfish.
    - Priority areas for contribution: Black marlin, blue marlin and striped marlin CPUE analysis and stock assessment.

152. The WPB **AGREED** that due to the contributions of Dr. Humber Andrade, it would be highly beneficial to facilitate his participation at the following core areas of expertise and priority areas for contribution that need to be enhanced for the next meeting of the WPB in 2013.

11.3. Date and place of the Eleventh Session of the Working Party on Billfish

153. The WPB participants were unanimous in thanking the Department of Agriculture, Forestry and Fisheries, South Africa for hosting the Tenth Session of the WPB and commended South Africa on the warm welcome, the excellent facilities and assistance provided to the IOTC Secretariat in the organisation and running of the Session.

154. Following a discussion on who would host the 11th Session of the WPB in 2013, the WPB **REQUESTED** that the IOTC Secretariat liaise with La Réunion to determine if it would be willing and able to host the 11th Session meeting in September 2013, in conjunction with the Working Party on Ecosystems and Bycatch. The exact dates and meeting location will be confirmed and communicated by the IOTC Secretariat to the SC for its consideration.

155. Following a discussion on who would host the 12th Session of the WPB in 2014, the WPB **REQUESTED** that the IOTC Secretariat liaise with CPCs to determine a suitable host for the 12th Session in September 2014, in conjunction with the Working Party on Ecosystems and Bycatch. The tentative dates and meeting location will be communicated by the IOTC Secretariat to the SC for its consideration.

11.4. Review of the draft, and adoption of the Report of the Tenth Session of the Working Party on Billfish

156. **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 10/02 and 12/03 data on billfish fisheries, in particular for the marlins, remain largely unreported by CPCs; thus the WPB **RECOMMENDED** that the SC address these concerns to the Compliance Committee and the Commission in order for them to take steps to develop mechanisms which would ensure that CPCs fulfill their reporting obligations.

157. The WPB **RECOMMENDED** that the SC consider the consolidated set of recommendations arising from WPB10, provided at Appendix IV.

158. The report of the Tenth Session of the Working Party on Billfish (IOTC–2012–WPB10–R) was **ADOPTED** on the 15 September 2012.

APPENDIX I
LIST OF PARTICIPANTS

Chairperson
Mr. Jerome **Bourjea**
IFREMER
La Réunion, France
Email:
Jerome.Bourjea@ifremer.fr

Vice-Chairperson
Dr. Miguel Neves **Santos**
Instituto Português do Mar e da Atmosfera (IPMA)
Portugal
Email: mnsantos@ipma.pt

Invited Expert
Dr. Humber Agrelli **Andrade**
Universidade Federal Rural de Pernambuco – UFRPE
Brazil
Email:
humber.andrade@gmail.com

Other participants
Dr. Pascal **Bach**
IRD
France
Email: pascal.bach@ird.fr

Dr. Rui **Coelho**
Instituto Português do Mar e da Atmosfera (IPMA)
Portugal
Email: rpcoelho@ipma.pt

Mr. Jose Ramón **Fernández** Costa
Instituto Español de Oceanografía
Paseo Marítimo F. Vázquez,
Spain
Email: jose.costa@co.ieo.es

Mr. Ahmed Riyaz **Jauharee**
Marine Research Centre, Ministry of Fisheries and Agriculture
Maldives
Email: arjauhary@yahoo.com / arjauharee@mrc.gov.mv

Ms. Marisa **Kashorte**
Intergovernmental and International Relations
DAFF
South Africa
Email: MarisaK@daff.gov.za

Dr. Sven Ebo **Kerwath**
Department of Agriculture, Forestry and Fisheries
South Africa
Email: SvenK@daff.gov.za

Dr. Francis **Marsac**
IRD
University of Cape Town South Africa
Email: francis.marsac@ird.fr

Mr. Julien **Million**
Fishery Officer
Indian Ocean Tuna Commission
Seychelles
Email: jm@iotc.org

Dr. Tom **Nishida**
National Research Institute of Far Seas Fisheries
Japan
Email: tnishida@affrc.go.jp

Ms. Barbara **Palha de Sousa**
Instituto de Investigação Pesqueira
Mozambique
Email: bsousa2@gmail.com

Mr. Diary Mirindra **Rahombanjanahary**
Ministry of Fisheries
Unité Statistique Thonière d'Antsiranana
Madagascar
Email: diarmirindra@yahoo.fr

Mr. Fariborz **Rajaei**
Iran Fisheries Organization
Iran (Islamic Republic of)
Email: rajaeif@gmail.com

Dr. Evgeny **Romanov**
CAP RUN / ARDA / PROSPER Project
La Réunion, France
Email: evgeny.romanov@ird.fr

Dr. Rishi **Sharma**
Fishery Officer (Stock Assessment)
Indian Ocean Tuna Commission
Seychelles
Email: rishi.sharma@iotc.org

Mr. Craig **Smith**
Department of Agriculture Forestry and Fisheries
South Africa
Email: craigs@daff.gov.za

Dr. Haputhantrige **Sujeewa**
National Aquatic Resources Research and Development Agency
Sri Lanka
Email:
sisirahaputhantri@yahoo.com

Dr. Sheng-Ping **Wang**
National Taiwan Ocean University
Taiwan,China
Email: wsp@mail.ntou.edu.tw

Ms. Wendy Megan **West**
Department of Agriculture, Forestry and Fisheries
South Africa
Email: WendyW@daff.gov.za

Mr. Christopher **Wilke**
Department of Agriculture, Forestry and Fisheries
South Africa
Email:
ChristopherW@daff.gov.za

Dr. David **Wilson**
Deputy Secretary/Science Manager
Indian Ocean Tuna Commission
Seychelles
Email: david.wilson@iotc.org

APPENDIX II
AGENDA FOR THE TENTH WORKING PARTY ON BILLFISH

Date: 11–15 September 2012
Location: 15 On Orange Hotel
15 Orange Street, Cape Town, South Africa
Time: 09:00 – 17:00 daily
Chair: Dr. Jeromé Bourjea; **Vice-Chair**: Dr. Miguel Neves dos Santos

1. **OPENING OF THE MEETING** (Chair)

2. **ADOPTION OF THE AGENDA AND ARRANGEMENTS FOR THE SESSION** (Chair)

3. **OUTCOMES OF THE FOURTEENTH SESSION OF THE SCIENTIFIC COMMITTEE** (Secretariat)

4. **OUTCOMES OF SESSIONS OF THE COMMISSION**
   - 4.1 Outcomes of the Sixteenth Session of the Commission (Secretariat)
   - 4.2 Review of Conservation and Management Measures relating to billfish (Secretariat)

5. **PROGRESS ON THE RECOMMENDATIONS OF WPB09** (Chair and Secretariat)

6. **MARLINS**
   - 6.1 Review of data available at the secretariat for marlins (Secretariat)
   - 6.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
   - 6.3 Review of new information on the status of marlins (all)
     - ➢ Nominal and standardised CPUE indices
     - ➢ Stock assessments
     - ➢ Selection of Stock Status indicators for marlins
   - 6.4 Development of management advice for marlins (all)
   - 6.5 Update of marlin species Executive Summaries for the consideration of the Scientific Committee (all)

7. **SAILFISH**
   - 7.1 Review of data available at the secretariat for sailfish (Secretariat)
   - 7.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
   - 7.3 Review of new information on the status of sailfish (all)
     - ➢ Nominal and standardised CPUE indices
     - ➢ Stock assessments
     - ➢ Selection of Stock Status indicators for sailfish
   - 7.4 Development of management advice for sailfish (all)
   - 7.5 Update of sailfish species Executive Summaries for the consideration of the Scientific Committee (all)

8. **SWORDFISH**
   - 8.1 Review of data available at the secretariat for swordfish (Secretariat)
   - 8.2 Review new information on the biology, stock structure, fisheries and associated environmental data (all)
     - ➢ Southwest Indian Ocean
     - ➢ Indian Ocean-wide
   - 8.3 Review of new information on the status of swordfish (all)
     - ➢ Nominal and standardised CPUE indices
     - ➢ Stock assessments
     - ➢ Selection of Stock Status indicators for swordfish
   - 8.4 Development of management advice for swordfish (all)
   - 8.5 Update of swordfish Executive Summaries for the consideration of the Scientific Committee (all)
     - ➢ Southwest Indian Ocean
     - ➢ Indian Ocean-wide

9. **EFFECT OF PIRACY ON BILLFISH FISHERIES** (Chair)
   SC14.46 (para. 127) In response to the request of the Commission (para. 40 of the S15 report), the SC RECOMMENDED that given the lack of quantitative analysis of the effects of piracy on fleet operations and subsequent catch and effort trends, and the potential impacts of piracy on fisheries in other areas of the Indian Ocean through the relocation of longliners to other fishing grounds, specific analysis should

be carried out and presented at the next WPTT meeting by the CPCs most affected by these activities, including Japan, Republic of Korea and Taiwan,China.

10. RESEARCH RECOMMENDATIONS AND PRIORITIES

10.1 Revision of the WPB work plan (Chair)

11. OTHER BUSINESS

11.1 Risk-based approaches to determining stock status (Secretariat)
11.2 Development of priorities for an Invited Expert at the next WPB meeting (Chair)
11.3 Date and place of the Eleventh Session of the Working Party on Billfish (Chair and Secretariat)
11.4 Review of the draft, and adoption of the Report of the Tenth Session of the Working Party on Billfish (Chair)

APPENDIX III
LIST OF DOCUMENTS

Document	Title	Availability
IOTC–2012–WPB10–01a	Draft agenda of the Tenth Working Party on Billfish	✓(12 June, 2012)
IOTC–2012–WPB10–01b	Draft annotated agenda of the Tenth Working Party on Billfish	✓(7 September, 2012)
IOTC–2012–WPB10–02	Draft list of documents	✓(14 August, 2012)
IOTC–2012–WPB10–03	Outcomes of the Fourteenth Session of the Scientific Committee (Secretariat)	✓(14 August, 2012)
IOTC–2012–WPB10–04	Outcomes of the Sixteenth Session of the Commission (Secretariat)	✓(14 August, 2012)
IOTC–2012–WPB10–05	Review of Conservation and Management Measures relating to billfish (Secretariat)	✓(14 August, 2012)
IOTC–2012–WPB10–06	Progress made on the recommendations of WPB09 (Secretariat and Chair)	✓(27 August, 2012)
IOTC–2012–WPB10–07	Review of the statistical data and fishery trends for billfish (Secretariat)	✓(25 July, 2012)
IOTC–2012–WPB10–08	Draft billfish identification cards (Secretariat)	✓(7 September, 2012)
IOTC–2012–WPB10–09	Analysis of billfish landings made by small fresh tuna longline vessels operated from Sri Lanka during 2005 – 2009 (S.S.K. Haputhantri)	✓(27 August, 2012)
IOTC–2012–WPB10–10	Catch Per Unit Effort of billfish caught by Malagasy longliners from 2010 to 2011 (D. M. Rahombanjanahary)	✓(28 August, 2012)
IOTC–2012–WPB10–11	A brief overview of the swordfish catches by the Portuguese pelagic longline fishery in the Indian Ocean: catch, effort, CPUE and catch-at-size (M.N. Santos, R. Coelho and P.G. Lino)	✓(28 August, 2012)
IOTC–2012–WPB10–12	Billfish fishery of Maldives (R. Jauharee and MS. Adam)	✓(31 August, 2012)
IOTC–2012–WPB10–13	Present status of Billfish fishery in Iran (F. Rajaei)	✓(31 August, 2012)
IOTC–2012–WPB10–14	Billfish caught in Mozambican waters (B.P. Sousa)	✓(3 August, 2012)
IOTC–2012–WPB10–15	Microsatellite and mtDNA markers were unable to reveal genetic population structure of swordfish (*Xiphias gladius*) in the Indian Ocean (D. Muths, S. Le Couls, H. Evano, P. Grewe and J. Bourjea)	✓(30 August, 2012)
IOTC–2012–WPB10–16	Horizontal and vertical movements of swordfish tagged with pop-up satellite transmitters in the south-west Indian Ocean, off South Africa (W.M. West, S. Kerwath, C. da Silva, C.G. Wilke and F. Marsac)	✓(7 September, 2012)
IOTC–2012–WPB10–17	Atlas of the drifting longline fishery of La Réunion island, Indian Ocean (H. Evano and J. Bourjea)	✓(7 September, 2012)
IOTC–2012–WPB10–18	Size distribution and length-weight relationships for some billfish (marlins, spearfish and swordfish) in the Indian Ocean (E.V. Romanov and N.V. Romanova)	✓(11 September, 2012)
IOTC–2012–WPB10–19 Rev_2	Standardization of catch rates for Striped marlin (*Tetrapturus audax*) and Blue marlin (*Makaira nigricans*) in the Indian Ocean based on the operational catch and effort data of the Japanese tuna longline fisheries incorporating time-lag environmental effects (1971–2011) (T. Nishida, Y. Shiba, H. Matsuura and S.-P. Wang)	✓(6 September, 2012) ✓(11 September, 2012) ✓(14 September, 2012)
IOTC–2012–WPB10–20 Rev_1	CPUE standardization of blue marlin (*Makaira mazara*) caught by Taiwanese longline fishery in the Indian Ocean for 1980 to 2010 (S.-P. Wang, S.-H. Lin and T.Nishida)	✓(7 September, 2012) ✓(9 September, 2012)
IOTC–2012–WPB10–21 Rev_1	CPUE standardization of striped marlin (*Tetrapterus audax*) caught by Taiwanese longline fishery in the Indian Ocean for 1980 to 2010 (S.P. Wang and T. Nishida)	✓(7 September, 2012) ✓(9 September, 2012)
Information papers		
IOTC–2012–WPB10–INF01	IOTC SC – Guidelines for the Presentation of Stock Assessment Models	✓(12 June, 2012)
IOTC–2012–WPB10–INF02	WCPFC SC – Stock assessment of striped marlin (*Kajikia audax*) in the southwest Pacific Ocean (N. Davies, S. Hoyle and J. Hampton)	✓(27 August, 2012)

Document	Title	Availability
IOTC–2012–WPB10–INF03	WCPFC SC – Progress towards a stock assessment for swordfish in the southern WCPO including standardized CPUE for Spanish swordfish fleet (S. Harley, P. Kleiber and S. Hoyle)	✓(27 August, 2012)
IOTC–2012–WPB10–INF04	Catch per unit effort and size composition of striped marlin caught by recreational fisheries in southeast Australian waters (D. Ghosn, D. Collins, C. Baiada and A. Steffe)	✓(27 August, 2012)
IOTC–2012–WPB10–INF05	Spatial dynamics of swordfish in the south Pacific Ocean inferred from tagging data (K. Evan, D. Kolody, F. Abascal, J. Holdsworth, P. Maru and T. Sippel)	✓(27 August, 2012)
IOTC–2012–WPB10–INF06	Catches and CPUE of billfishes from La Réunion Sport Fishery from 2001 to 2011 fishing seasons (P.-G. Fleury and J. Bourjea)	✓(30 August, 2012)
IOTC–2012–WPB10–INF07	Oceanographic research institute's (ORI) voluntary fish tagging project 1984–2011 (S. Dunlop and B. Mann)	✓(11 September, 2012)
IOTC–2012–WPB10–INF08	Information provided by the Secretariat as updates to two recommendations from the previous WPB (WPB09 Recs 10 and 11) (IOTC Secretariat)	✓(7 September, 2012)
IOTC–2012–WPB10–INF09	High value and long life—double jeopardy for tunas and billfishes (B.B. Collette et al.)	✓(8 September, 2012)
IOTC–2012–WPB10–INF10	Supporting online material for: High value and long life—double jeopardy for tunas and billfishes (B.B. Collette et al.)	✓(8 September, 2012)
IOTC–2012–WPB10–INF11	IOTC CE data – Exploratory analysis – longline (H.A. Andrade)	✓(12 September, 2012)
IOTC–2012–WPB10–INF12	Standardized catch rates (H.A. Andrade)	✓(12 September, 2012)
IOTC–2012–WPB10–INF13	Phylogeny of recent billfishes (Xiphioidei) (B.B. Collette, J.R. McDowell and J.E. Graves)	✓(13 September, 2012)

APPENDIX IV
CONSOLIDATED RECOMMENDATIONS OF THE TENTH SESSION OF THE WORKING PARTY ON BILLFISH

Note: Appendix references refer to the Report of the Tenth Session of the Working Party on Billfish (IOTC–2012–WPB10–R)

Billfish species identification

WPB10.01 (para. 17): The WPB **RECOMMENDED** that the SC request that the Commission allocate additional funds in 2013 to print further sets of the identification cards, noting that expected costs are in the vicinity of US$5,500 per 1000 sets of cards.

WPB10.02 (para. 18): The WPB **RECOMMENDED** that IOTC CPCs translate, print and disseminate the identification cards to their observers and field samplers (Resolution 11/04), and as feasible, to their fishing fleets targeting tuna, tuna-like and shark species. This would allow accurate observer, sampling and logbook data on billfish to be recorded and reported to the IOTC Secretariat as per IOTC requirements.

Length-age keys

WPB10.03 (para. 20): The WPB **RECOMMENDED** that as a matter of priority, CPCs that have important fisheries catching billfish (EU, Taiwan,China, Japan, Indonesia and Sri Lanka) to collect and provide basic or analysed data that would be used to establish length-age keys and non-standard measurements to standard measurements keys for billfish species, by sex and area.

Catch, Catch-and-effort, Size data

WPB10.04 (para. 21): The WPB reiterated its **RECOMMENDATION** from 2011 that the IOTC Secretariat liaise with the EU,Spain in order to assess and improve the status of catch-and-effort data for marlins and sailfish.

WPB10.05 (para. 22): The WPB reiterated its previous **RECOMMENDATION** that the EU,Spain longline fleet provide the IOTC Secretariat with catch-and-effort and size data of marlins and sailfish by time and area strata, noting that this is already a mandatory reporting requirement.

WPB10.06 (para. 23): The WPB reiterated its previous **RECOMMENDATION** that Japan resume size sampling on its commercial longline fleet, and that Taiwan,China provide size data for its fresh longline fleet to attain the minimum recommended by the Commission (1 fish by metric ton of catch by type of gear and species).

WPB10.07 (para. 24): The WPB reiterated its previous **RECOMMENDATION** that Indonesia and India provide catch-and-effort and size frequency data for their longline fleets.

WPB10.08 (para. 25): The WPB reiterated its previous **RECOMMENDATION** that CPCs having artisanal and semi-industrial fleets, in particular Iran, Pakistan, Sri Lanka, provide catch and effort as well as size data as per IOTC requirements for billfish caught by their fleets.

WPB10.09 (para. 26): The WPB **NOTED** that all CPCs are not collecting size with standard measurements, and **RECOMMENDED** that only lower-jaw to fork length, eye to fork length or pectoral to second dorsal length are taken by fisher, samplers and observers.

WPB10.10 (para. 27): The WPB reiterated its previous **RECOMMENDATION** that the EU record and report information on catches of billfish, by species, for its purse seine fisheries.

Data inconsistencies

WPB10.11 (para. 28): Noting the progress made to date, the WPB **RECOMMENDED** that the IOTC Secretariat finalize the study aimed at assessing the consistency of average weights derived from the available catch and effort data, as derived from logbooks, and size data provided by Japan, Taiwan,China, Seychelles and EU,Spain and to report final results at the next WPB meeting.

WPB10.12 (para. 29): The WPB reiterated its **RECOMMENDATION** from 2011 that as a matter of priority, India, Iran and Pakistan provide catch-and-effort data and size data for billfish, in particular gillnet fisheries, as soon as possible, noting that this is already a mandatory reporting requirement. As part of this process, these CPCs shall use the billfish identification cards to improve the identification of marlin species caught by their fisheries.

Sports fisheries

WPB10.13 (para. 34): The WPB **RECOMMENDED** that the IOTC Secretariat develop a list of contacts of Institutes, Foundations and NGOs implementing tagging programs of large pelagic fishes in the Indian Ocean and to summarise this information for presentation at the next WPB meeting.

Review of data available at the secretariat for marlins

WPB10.14 (para. 36): The WPB **NOTED** the main marlin data issues that are considered to negatively affect the quality of the statistics available at the IOTC Secretariat, by type of dataset and fishery, which are provided in Appendix VI, and **RECOMMENDED** that the CPCs listed in the Appendix, make efforts to remedy the data issues identified and to report back to the WPB at its next meeting.

WPB10.15 (para. 37): The WPB **NOTED** that the quality of the data available at the IOTC Secretariat on marlins is likely to be compromised by species miss-identification and **RECOMMENDED** that CPCs review their historical data in order to identify and correct potential identification problems that are detrimental to any analysis of the status of the stocks.

Sri Lankan billfish landings

WPB10.16 (para. 39): **NOTING** that to date, Sri Lanka has been unable to provide accurate statistics for billfish species to the IOTC, due to poor species identification and low levels of sampling coverage for its coastal and offshore fisheries; the WPB **RECOMMENDED** that as a matter of priority, Sri Lanka increase sampling coverage to attain at least the coverage levels recommended by the Commission (1 fish by metric ton of catch by type of gear and species), including:

- catches sampled or observed for at least 5% of the vessel activities for coastal fisheries, including collection of catch, effort and size data for IOTC species and main bycatch species;
- implementation of logbook systems for offshore fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03.

The information collected through the above activities should allow Sri Lanka to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

Madagascar's billfish landings

WPB10.17 (para. 42): **NOTING** that the longline fishery in Madagascar is a new and developing fishery, the WPB **RECOMMENDED** that Madagascar ensure that it develops and implements a data collection system, including sampling, logbooks and observers, which would adequately cover the entire fishery.

Maldives billfish landings

WPB10.18 (para. 44): The WPB **NOTED** that the level of capture of marlins from the Maldivian artisanal fishery appears to be very high compared to the total catches reported for the Indian Ocean and **RECOMMENDED** that the Maldives provide a review of its landings of each marlin species at the next WPB meeting.

WPB10.19 (para. 45): The WPB **RECOMMENDED** that the Maldives implement data collection systems, through logbooks and sampling for its fisheries that incorporate species level information requirements for billfish, as per IOTC Resolution 12/03. The information collected should allow the Maldives to estimate species level catches by gear for billfish and other important IOTC or bycatch species.

Mozambique billfish landings

WPB10.20 (para. 53): **NOTING** that at present no scientific observers are being placed on board foreign flagged vessels licenced to fish in the Mozambique EEZ, the WPB **RECOMMENDED** that Mozambique make it a licencing requirement for any foreign vessels fishing in the Mozambique EEZ to take on board scientific observers and to report the data collected as per IOTC requirements. Foreign vessels fishing in the Mozambique EEZ should ensure that scientific observers are brought onboard as per IOTC requirements.

Review of fleet dynamics

WPB10.21 (para. 85): The WPB **RECOMMENDED** that both Japan and Taiwan,China undertake a complete historical review of their longline data and to document the changes in fleet dynamics for presentation and the next WPB meeting. The historical review should include as much explanatory information as possible regarding changes in fishing areas, species targeting, gear changes and other fleet characteristics to assist the WPB understand the current fluctuations observed in the data.

Parameters for future analyses: stock assessments

WPB10.22 (para. 105): **NOTING** that the current time frames for data exchange do not allow enough time to conduct thorough stock assessment analyses, and this could have a detrimental effect on the quality of advice provided by the WPB, the WPB **RECOMMENDED** that exchanges of data (CPUE indicies and coefficient of variation) should be made as early as possible, but no later than 30 days prior to a working party meeting, so that stock assessment analysis can be provided to the IOTC Secretariat no later than 15 days before a working party meeting, as per the recommendations of the SC, which states: "*The SC also ENCOURAGED data to be used in stock assessments, including CPUE standardisations, be made available not less than three months before each meeting by CPCs and where possible, data summaries no later than two months prior to each meeting, from the IOTC Secretariat; and RECOMMENDED that data to be used in stock assessments, including CPUE standardisations be made available not less than 30 days before each meeting by CPCs*." (IOTC–2011–SC14–R; p68)

Development of management advice for marlins

WPB10.23 (para. 110): The WPB **RECOMMENDED** that the SC note the management advice developed for marlins as provided in the draft resource stock status summaries:

- Black marlin (*Makaira indica*) – Appendix VII
- Blue marlin (*Makaira nigricans*) – Appendix VIII
- Striped marlin (*Tetrapterus audax*) – Appendix IX

Development of management advice for Indo-Pacific sailfish

WPB10.24 (para. 119): The WPB **RECOMMENDED** that the SC note the management advice developed for Indo-Pacific sailfish (*Istiophorus platypterus*), as provided in the draft resource stock status summary (Appendix X).

Indian Ocean Swordfish Stock Structure project (IOSSS)

WPB10.25 (para. 127): The WPB **RECOMMENDED** that the SC note that although the results of the IOSSS project did not reveal any structure within the Indian Ocean with the markers used, however the hypothesis of a population structuring at the regional level cannot be discarded and needs to be investigated using different markers or approaches. Results obtained from the markers used may simply be a matter of the resolving power of the markers used, which may simply have been insufficient for detecting population subdivision.

Swordfish: European Union longline fisheries CPUE indicies

WPB10.26 (para. 130): The WPB **RECOMMENDED** that scientists from EU,Portugual and EU,Spain undertake a revised CPUE analysis for their longline fleets, and consider combining the analysis prior to the next WPB meeting where swordfish will be dealt with as a priority.

Development of management advice for swordfish

WPB10.27 (para. 139): The WPB **RECOMMENDED** that the SC note the management advice developed for swordfish (*Xiphias gladius*), as provided in the draft resource stock status summary (Appendix XI).

Effect of piracy on billfish fisheries

WPB10.28 (para. 143): The WPB **RECOMMENDED** that given the potential impacts of piracy on billfish fisheries, specific analysis should be carried out and presented at the next WPB meeting by the CPCs most affected by these activities, including Japan, Rep. of Korea and Taiwan,China.

Revision of the WPB workplan

WPB10.29 (para. 145): The WPB **RECOMMENDED** that the Istiophorids (striped marlin, blue marlin, black marlin and Indo-Pacific sailfish) undergo new or revised CPUE analysis in 2013, taking into account the various points in the CPUE discussion summaries throughout this report).

WPB10.30 (para. 146): The WPB **RECOMMENDED** the following core areas as priorities for research over the coming year;

- Billfish species biology (i.e. growth reproduction)
- Size data analyses
- Stock status indicators – exploration of indicators from the available data

- Striped marlin, blue marlin and black marlin CPUE standardisation
- Stock assessment – Istiophorids

Risk-based approaches to determining stock status

WPB10.31 (para. 149): The WPB **RECOMMENDED** that the IOTC Secretariat facilitate a process to provide the necessary information to the SC so that it may consider the Weight-of-Evidence approach to determine species stock status, as an addition to the current approach of relying solely on fully quantitative stock assessment techniques.

Review of the draft, and adoption of the Report of the Tenth Session of the Working Party on Billfish

WPB10.32 (para. 156): **NOTING** that despite the mandatory reporting requirements detailed in Resolutions 10/02 and 12/03 data on billfish fisheries, in particular for the marlins, remain largely unreported by CPCs; thus the WPB **RECOMMENDED** that the SC address these concerns to the Compliance Committee and the Commission in order for them to take steps to develop mechanisms which would ensure that CPCs fulfill their reporting obligations.

WPB10.33 (para. 157): The WPB **RECOMMENDED** that the SC consider the consolidated set of recommendations arising from WPB10, provided at Appendix IV.

APPENDIX V
MAIN STATISTICS OF BILLFISH

Extract from IOTC–2012–WPB10–07

Black marlin (Makaira indica)

Catch trends

Black marlin are caught mainly by drifting longlines (44%) and gillnets (49%) with remaining catches taken by troll and hand lines (**Table 1, Fig. 1**). Black marlin are not targeted by industrial fisheries, but is targeted by some artisanal and sport/recreational fisheries. Black marlin are also known to be taken in purse seine fisheries, but are not currently being reported. In recent years, the fleets of **Taiwan,China** (longline), **Sri Lanka** (gillnet), **Indonesia** (gillnets) and **India** (gillnets) are attributed with the highest catches of black marlin (**Fig. 2**). The minimum average annual catch estimated for the period 2006 to 2010 is 6,085 t (**Table 1**), although this figure is considered to be a gross underestimate due to under reporting and misidentification.

Between the early-1950s and the late-1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, and reported very high catches of black marlin in that area, in particular in waters off northwest Australia. In recent years, deep-freezing longliners from Japan and Taiwan,China have reported lower catches of black marlin, mostly in waters off the western coast of India and, to a lesser extent, the Mozambique Channel (**Fig. 3**).

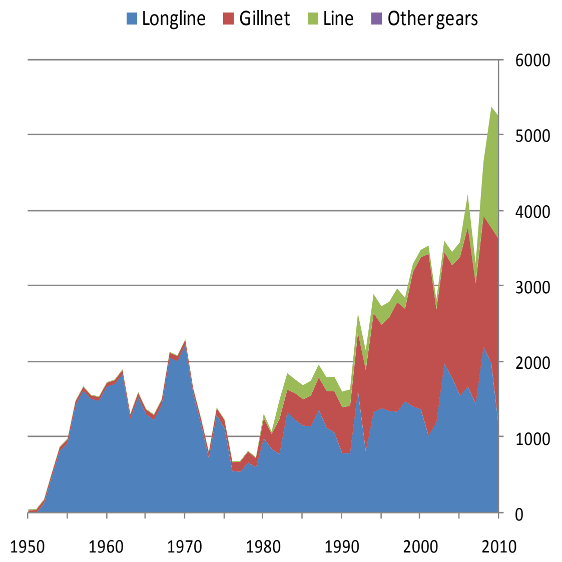


Fig. 1. Catches of black marlin per gear and year recorded in the IOTC Database (1960–2010).

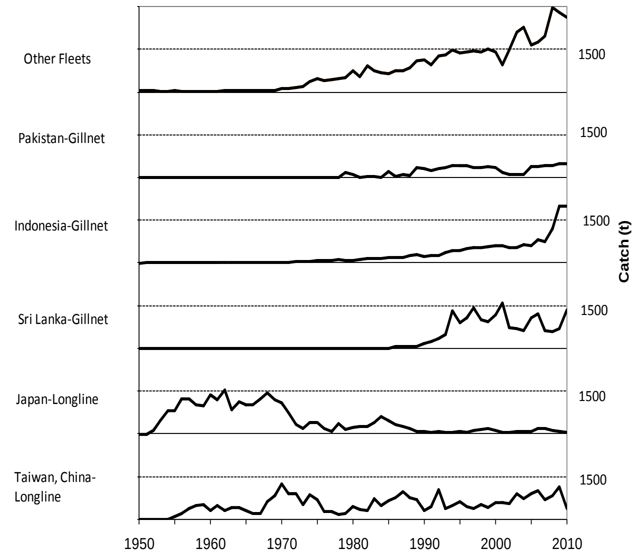


Fig. 2. Catches of black marlin by fleet recorded in the IOTC Database (1960–2010).

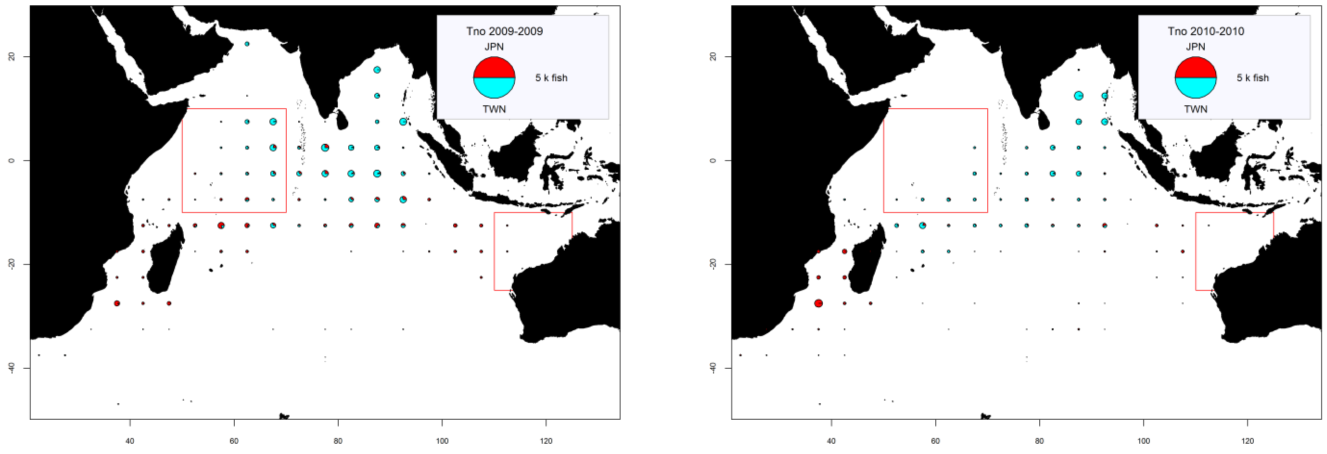


Fig. 3a–b. Time-area catches (in number of fish) of black marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 1. Best scientific estimates of the catches of black marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of July 2012.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LL	846	1,633	1,288	1,370	1,500	1,943	1,235	1,440	2,288	2,005	2,003	2,109	1,847	2,634	2,230	1,374
GN	47	60	118	491	1,781	2,278	2,608	1,634	1,626	1,629	2,259	2,687	2,063	2,469	3,412	4,172
HL	15	19	25	177	244	694	196	451	574	926	487	624	773	1,063	1,580	1,389
OT	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	**908**	**1,712**	**1,435**	**2,038**	**3,525**	**4,914**	**4,040**	**3,525**	**4,487**	**4,560**	**4,750**	**5,420**	**4,682**	**6,166**	**7,221**	**6,935**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are uncertain for some fisheries (**Fig. 4**), due to the fact that:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of **Sri Lanka** and artisanal fisheries of **India**, **Iran** and **Pakistan**) and industrial (longliners of **Indonesia** and **Philippines**) fisheries.
- catches of non-reporting industrial longliners (**India**, **NEI**) and the gillnet fishery of **Indonesia** are estimated by the Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the black marlin is not a target species.
- conflicting catch reports: Longline catches from the **Republic of Korea** are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of black marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of black marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- the catch series used by the WPB in 2011 and that to be used for the WPB in 2012 are slightly different, following an increase in the catches estimated in recent years for the fleets of India (longline and trolling), and Indonesia (gillnet).
- **Discards** are unknown, but considered to be low for most industrial fisheries, mainly longliners. Discards of black marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

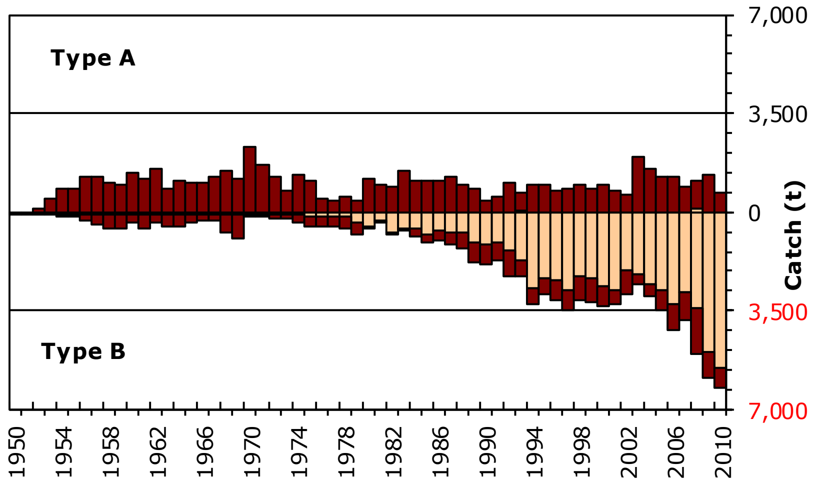


Fig. 4. Uncertainty of annual catch estimates for black marlin (Data as of July 2012)

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. The number of specimens measured on Japanese longliners in recent years is, however, very low (**Fig. 5**).

Catch-at-Size(Age) tables have not been built for black marlin due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

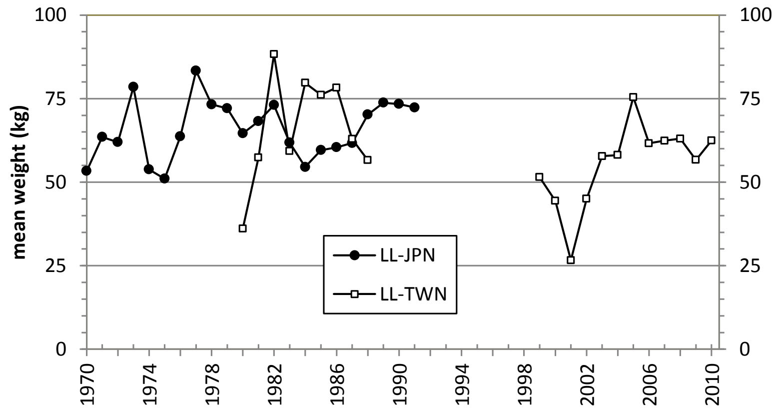


Fig. 5. Average weight of black marlin (kg) estimated from the size samples available for longliners of Japan (1970-2009) and Taiwan,China (1980-2010)

NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

Blue marlin (Makaira nigricans)

Catch trends

Blue marlin are caught mainly by drifting longlines (60%) and gillnets (30%) with remaining catches recorded under troll and hand lines (**Table 2**, **Fig. 6**). Blue marlin is an important target for several artisanal and sport/recreational fleets. Blue marlin are also known to be taken in purse seine fisheries, but are not currently being reported. The reported catches of blue marlin are higher than those of black marlin and striped marlin combined, although this is highly uncertain due to under reporting and misidentification. In recent years, the fleets of Taiwan,China (longline), Indonesia (longline and gillnet), Sri Lanka (gillnet) and India (gillnet) are attributed with the highest catches of blue marlin (**Fig. 7**). The distribution of blue marlin catches has changed since the 1980's with most of the reported catch now taken in the western areas of the Indian Ocean. However, non-reporting of catches by gillnet fleets in the northern Indian Ocean masks the true level of harvest in the Indian Ocean.

Catch trends for blue marlin are variable; this may reflect the variability of targeting by longline fleets and the level of reporting for other gears. The catches of blue marlin by drifting longline fisheries were more or less stable until the mid-80's, at around 3,000 t, steadily increasing since then. The largest catches were recorded in 1997 (~11,000 t). Longline catches have been recorded by **Taiwan,China** and **Japan** fleets and, recently, **Indonesia** and several **NEI** fleets (**Fig. 7**). In recent years, deep-freezing longliners from **Japan** and **Taiwan,China** have reported most of the catches of blue marlin in waters of the western and central tropical Indian Ocean and, to a lesser extent, the Mozambique Channel and the Arabian Sea (**Fig. 8**).

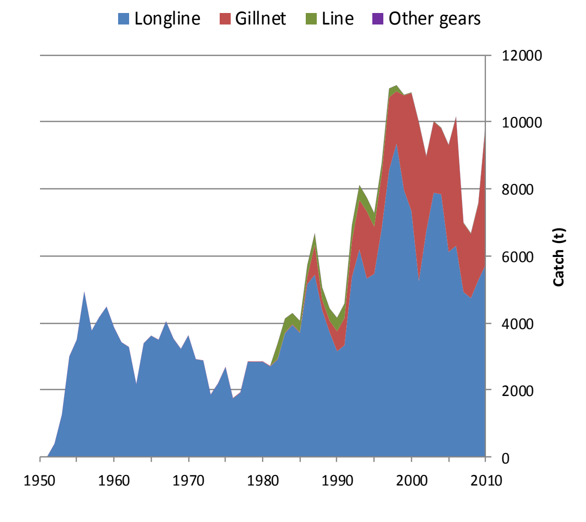


Fig. 6. Catches of blue marlin per gear and year recorded in the IOTC database (1950–2010).

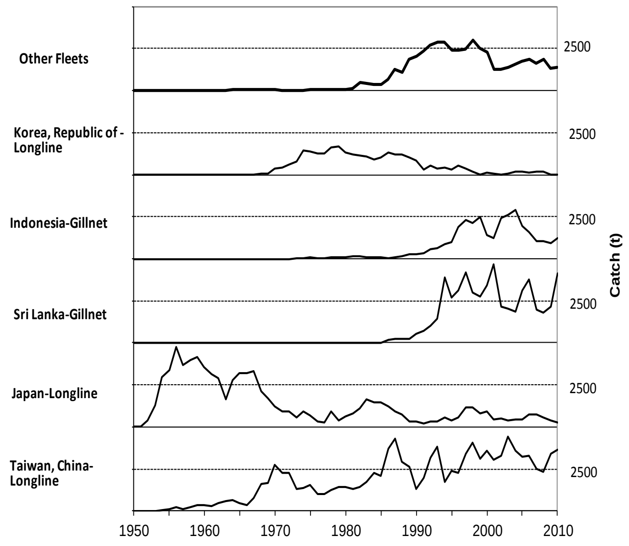


Fig. 7. Catches of blue marlin by fleet recorded in the IOTC database (1950–2010).

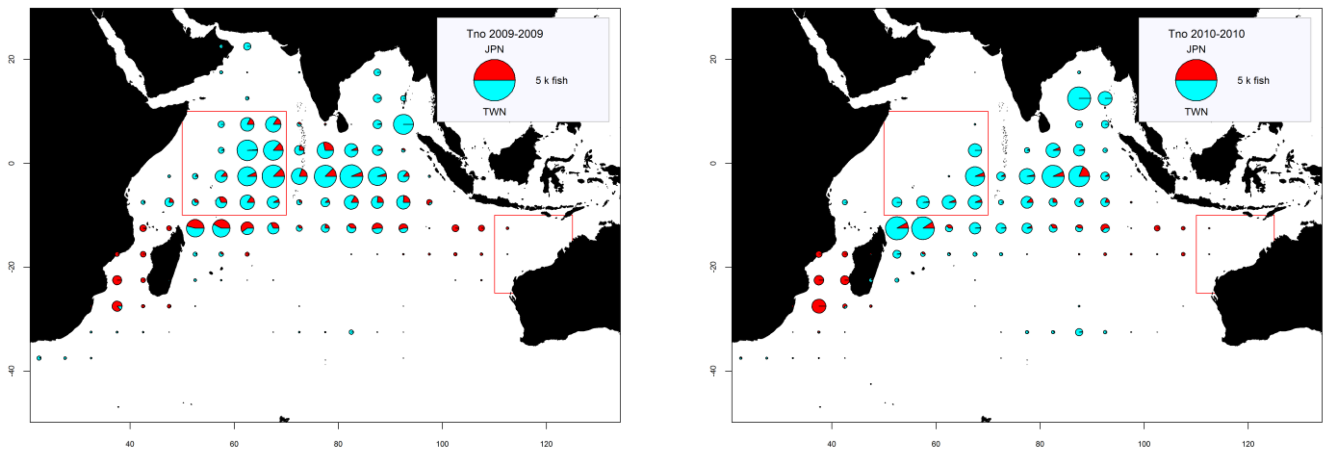


Fig. 8a–b. Time-area catches (in number of fish) of Indo-Pacific blue marlin as reported for the longline (LL) fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 2. Best scientific estimates of the catches of Indo-Pacific blue marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of July 2012.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LL	2,563	3,512	3,474	4,961	7,120	7,163	5,950	7,442	8,791	8,512	7,425	7,548	6,000	5,830	5,950	6,345
GN	3	4	10	192	2,407	2,787	4,732	2,219	2,124	1,972	3,188	3,843	2,061	1,922	2,281	4,260
HL	11	23	34	313	345	36	29	27	33	25	45	27	30	38	42	54
OT	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**2,576**	**3,540**	**3,518**	**5,466**	**9,872**	**9,986**	**10,711**	**9,689**	**10,948**	**10,508**	**10,657**	**11,418**	**8,090**	**7,790**	**8,272**	**10,660**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Difficulties in the identification of marlins also contribute to the uncertainties of the information available to the Secretariat.

Retained catches are poorly known for most fisheries (**Fig. 9**) due to:

- catch reports often refer to total catches of all three marlin species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of **Sri Lanka** and artisanal fisheries of **India**, **Iran** and **Pakistan**) and industrial (longliners of **Indonesia** and **Philippines**) fisheries.
- catches of non-reporting industrial longliners (**India**, **NEI**) and the gillnet fishery of **Indonesia** are estimated by the Secretariat using alternative information.
- catches are likely to be incomplete for industrial fisheries for which the blue marlin is not a target species.
- conflicting catch reports: Longline catches from the **Republic of Korea** are reported as nominal catches, and catch and effort reports are conflicting, with higher catches recorded in the catch and effort table. For this reason, the Secretariat revised the catches of blue marlin for the Republic of Korea over the time-series using both datasets. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of blue marlin remain uncertain for this fleet.
- a lack of catch data for most sport fisheries.
- There have not been significant changes to the catches of blue marlin since the WPB in 2011.
- **Discards** are unknown for most industrial fisheries, mainly longliners. Discards of blue marlin may also occur in the driftnet fishery of I.R. Iran, as this species has no commercial value in this country.

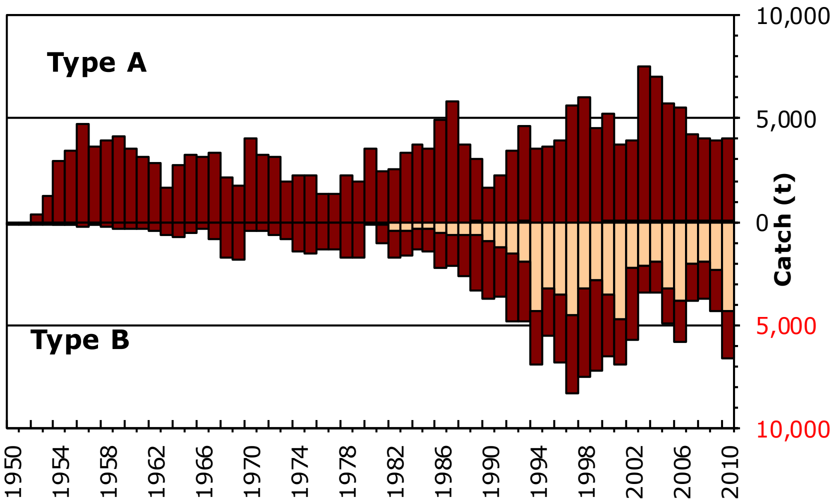


Fig. 9. Uncertainty of annual catch estimates for blue marlin (Data as of July 2012).

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of **Japan** since 1970 and **Taiwan,China** since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan (**Fig. 10**).

Catch-at-Size(Age) tables have not been built for blue marlin due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

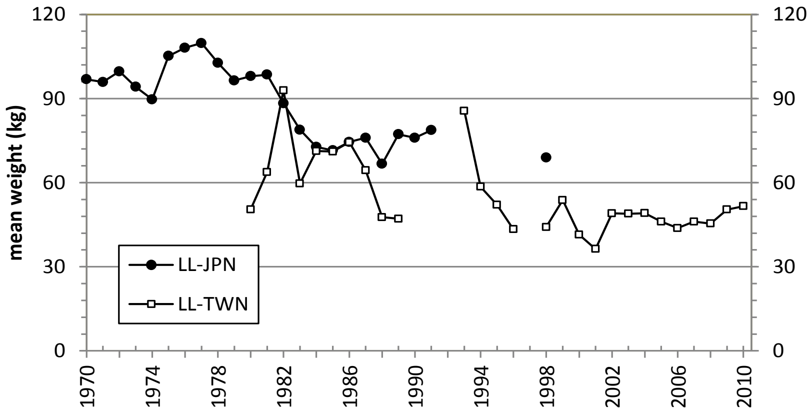


Fig. 10. Average weight of blue marlin (kg) estimated from the size samples available for longliners of Japan (1970-2009) and Taiwan,China (1980-2010).
NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

Striped marlin (Tetrapturus audax)

Catch trends

Striped marlin are caught almost exclusively by drifting longlines (98%) with remaining catches recorded by gillnets and troll lines (**Table 3, Fig. 11**). Striped marlin are also known to be taken in purse seine fisheries, but are not currently being reported. Catch trends for striped marlin are variable; however, this may reflect the level of targeting by longline fleets and the level. The catches of striped marlin by drifting longlines have been changing over time, between 2,000 t and 7,000 t (**Fig. 11**), although this is highly uncertain due to under reporting and misidentification.

Longline catches have been recorded by **Taiwan,China**, **Japan**, **Republic of Korea** fleets and, recently, **Indonesia** and several **NEI** fleets (**Fig. 12**). Taiwan,China and Japan have reported large drops in the catches of striped marlin for its longline fleets since the mid-1980’s and mid-1990’s, respectively. The reason for such decreases in catches is not fully understood. Between the early 1950s and the late 1980s part of the Japanese fleet was licensed to operate within the EEZ of Australia, reporting relatively high catches of striped marlin in the area, in particular in waters off northwest Australia. High catches of the species were also reported in the Bay of Bengal during this period, by both Taiwan,China and Japanese longliners. The distribution of reported striped marlin catches has changed since the 1980‘s with most of the catch now taken in the western areas of the Indian Ocean (**Fig. 13**). However, non-reporting of catches by the gillnet and troll line fisheries masks the true level of harvest in the Indian Ocean.

These changes of fishing area and catches over the years are thought to be related to changes in the type of access agreements to EEZs of coastal countries in the Indian Ocean, rather than changes in the distribution of the species over time. However, since 2007, catches in the northwest Indian Ocean have dropped markedly, in tandem with a reduction of longline effort in the area as a consequence of maritime piracy off Somalia (**Fig. 13**).

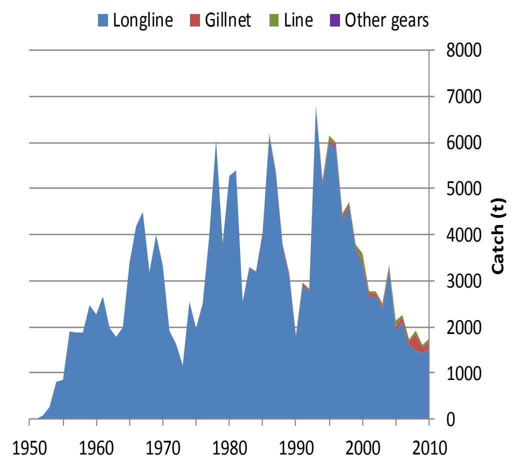


Fig. 11. Catches of striped marlin per gear and year recorded in the IOTC Database (1960–2010).

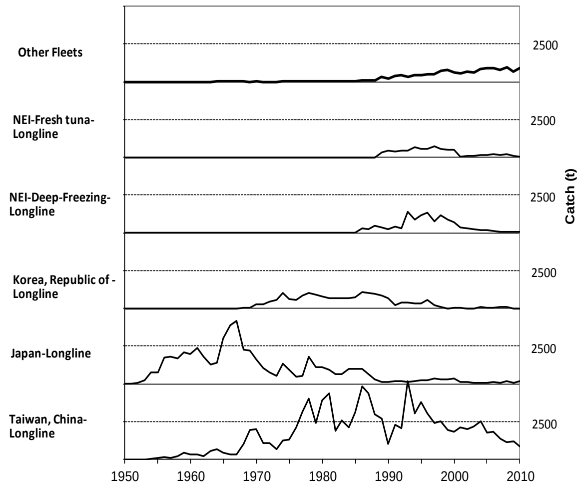


Fig. 12. Catches of striped marlin by fleet recorded in the IOTC Database (1960–2010).

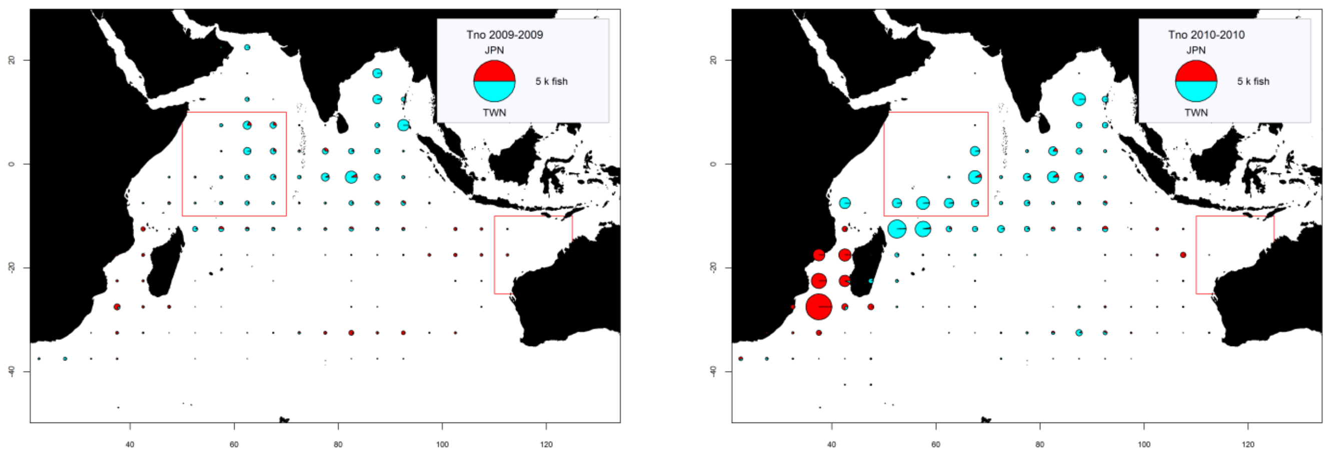


Fig. 13a–b. Time-area catches (in number of fish) of striped marlin as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet. Red lines represent the boundaries of the marlin hot spots identified by the WPB.

TABLE 3. Best scientific estimates of the catches of striped marlin by type of fishery for the period 1950–2010 (in metric tonnes). Data as of July 2012.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LL	1,024	3,077	3,614	5,042	5,040	2,945	3,071	3,114	3,115	3,709	2,946	3,075	2,405	2,263	1,904	1,883
GN	2	3	6	24	60	117	92	65	66	74	81	125	96	351	132	149
HL	-	-	2	11	47	71	51	41	65	39	127	41	48	71	54	59
OT	-	-	2	-	-	0	-	0	-	0	-	-	-	-	-	-
Total	**1,026**	**3,080**	**3,624**	**5,077**	**5,147**	**3,133**	**3,213**	**3,220**	**3,246**	**3,822**	**3,154**	**3,242**	**2,550**	**2,685**	**2,090**	**2,090**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**

Uncertainty of time–area catches

Retained catches are reasonably well known for the main industrial fleets (**Fig. 14**) although they remain uncertain for many smaller fleets:

- Catch reports refer to total catches of all three marlin species; catches by species have to be estimated by the IOTC Secretariat for some industrial fisheries (longliners of **Indonesia** and **Philippines**).
- Catches of non-reporting industrial longliners (**India**, **NEI**) estimated by the IOTC Secretariat using alternative information. As they are not reported by the countries concerned, catches are likely to be incomplete for some industrial fisheries for which the striped marlin is seldom the target species.

- Conflicting catch reports: The catches for longliners flagged to the **Republic of Korea**, reported as nominal catches and catches and effort, are conflicting with higher catches recorded in the catch and effort table. For this reason, the IOTC Secretariat revised the catches of striped marlin over the time-series using both datasets. Although the new catches estimated by the IOTC Secretariat are thought to be more accurate, catches of striped marlin remain uncertain for this fleet.
- There have not been significant changes to the catches of striped marlin since the WPB in 2010.
- **Discards** are thought to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of striped marlin may also occur in the driftnet fishery of Iran, as this species has no commercial value in this country.

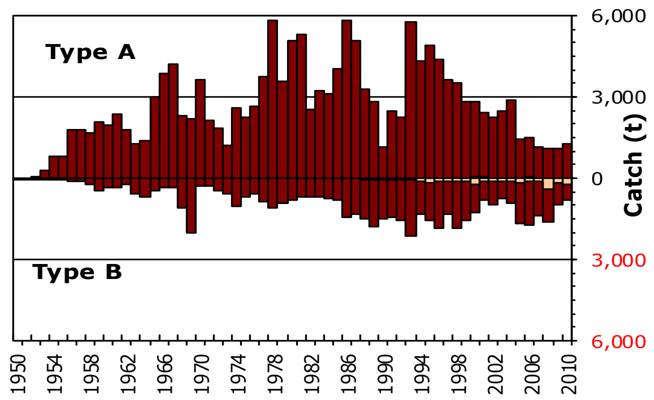


Fig. 14. Uncertainty of annual catch estimates for striped marlin (Data as of July 2012).

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and Taiwan,China since 1980. However, the number of specimens measured on Japanese longliners in recent years is very low and miss-identification of striped and blue marlin may be occurring in the Taiwanese longline fishery; the length frequency distributions derived from samples collected on Taiwanese longliners differ greatly from those collected on longliners flagged in Japan (**Fig. 15**).

Catch-at-Size(Age) tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

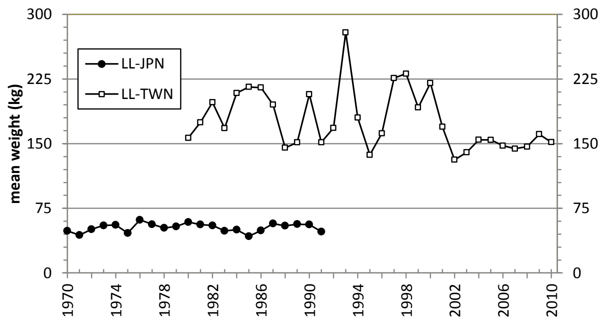


Fig. 15. Average weight of striped marlin (kg) estimated from the size samples available for longliners of Japan (1970–2009) and Taiwan,China (1980–2010).
NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

Indo-Pacific sailfish (Istiophorus platypterus)

Catch trends

Indo-Pacific sailfish is targeted by artisanal fisheries in the Maldives, Yemen and Sri Lanka and by sport/recreational fisheries including in Kenya, Mauritius and Seychelles. Indo-Pacific sailfish is caught mainly by gillnets (78%) with remaining catches reported from troll and hand lines (15%), longlines (7%) or other gears (**Table 4, Fig. 16**). I.P. sailfish are also known to be taken in purse seine fisheries, but are not currently being reported. The minimum average annual catch estimated for the period 2006 to 2010 is around 21,500 t, however this figure is highly uncertain due to under reporting and misidentification. In recent years, the countries attributed with the highest catches of Indo-Pacific sailfish are situated in the Arabian Sea (India, Iran, Pakistan and Sri Lanka). Smaller catches are reported for line fishers in Comoros and Mauritius and by Indonesia longliners.

Catches of Indo-Pacific sailfish greatly increased since the mid-1990's in response to the development of a gillnet/longline fishery in Sri Lanka (**Fig. 17**) and, especially, the extension in the area of operation of Iranian gillnet vessels to areas beyond the EEZ of I.R. Iran. The catches of Iranian gillnets (**Fig. 17**) increased dramatically, more than six-fold, after the late 1990's.

Catches of Indo-Pacific sailfish by drifting longlines (**Table 4**) and other gears do not show any specific trends in recent years. However, it is likely that longline fleets under report catches of this species due to its little commercial value. In recent years, deep-freezing longliners from Japan have reported catches of Indo-Pacific sailfish in the central western Indian Ocean, between Sri Lanka and the Maldives and the Mozambique Channel (**Fig. 18**).

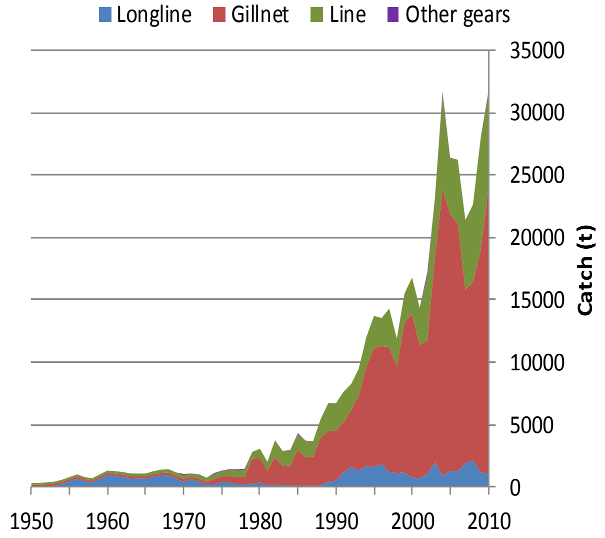


Fig. 16. Catches of Indo-Pacific sailfish per gear and year recorded in the IOTC Database (1960–2010).

Fig. 17. Catches of Indo-Pacific sailfish by fleet recorded in the IOTC Database (1960–2010).

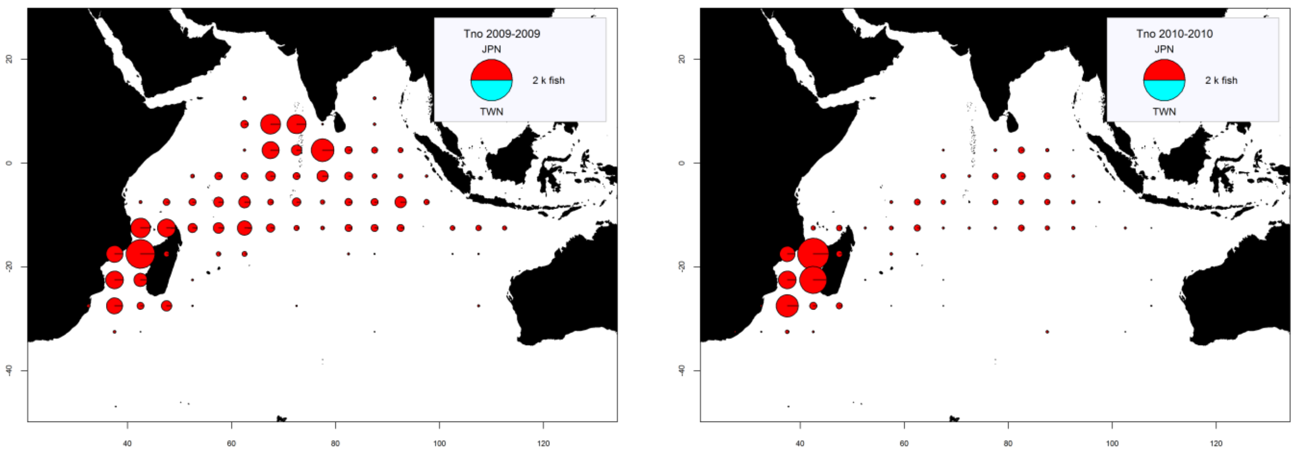


Fig. 18a–b. Time-area catches (in number of fish) of Indo-Pacific sailfish as reported for the longline fisheries of Japan (JPN) and Taiwan,China (TWN) for 2009 and 2010 by fleet.

TABLE 4. Best scientific estimates of the catches of Indo-Pacific sailfish by type of fishery for the period 1950–2010 (in metric tonnes). Data as of July 2012.

Fishery	By decade (average)						By year (last ten years)									
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
LL	299	819	449	343	1,425	1,417	791	1,149	2,037	934	1,397	1,402	2,062	2,270	1,243	1,144
GN	155	166	509	2,360	7,620	16,057	10,707	10,721	16,486	23,049	20,600	19,917	13,910	14,284	17,790	22,711
HL	164	240	416	1,271	2,370	5,365	2,979	5,143	4,728	7,493	4,528	5,076	5,591	6,228	8,951	7,795
OT	9	9	86	49	1	55	-	297	-	240	-	-	-	12	-	-
Total	**627**	**1,235**	**1,459**	**4,022**	**11,416**	**22,893**	**14,478**	**17,310**	**23,250**	**31,716**	**26,525**	**26,395**	**21,563**	**22,793**	**27,984**	**31,650**

Fisheries: Gillnet (**GN**); Longline (**LL**); Hook-and-Line (**HL**), including handline, trolling, baitboat, and sport fisheries; Other gears (**OT**)

Uncertainty of time–area catches

Minimum catch estimates have been derived from very small amounts of information and are therefore highly uncertain. Unlike the other billfish, Indo-Pacific sailfish are probably more reliably identified because of the large and distinctive first dorsal fin that runs most of the length of the body.

Retained catches are poorly known for most fisheries (**Fig. 19**) due to:

- Catch reports often refer to total catches of all billfish species combined; catches by species are estimated by the Secretariat for some artisanal (gillnet/longline fishery of Sri Lanka and artisanal fisheries of India and Pakistan) and industrial (longliners of Indonesia and Philippines) fisheries.
- Catches of IP sailfish reported for some fisheries may refer to the combined catches of more than one species of billfish, in particular marlins and shortbill spearfish (gillnet fishery of Iran and many coastal fisheries).
- Catches likely to be incomplete for some artisanal fisheries (gillnets of Pakistan, pole and lines of Maldives) due to under-reporting.
- Catches are likely to be incomplete for industrial fisheries for which the Indo-Pacific sailfish is not a target species.
- A lack of catch data for most sport fisheries.
- There have not been significant changes to the catches of Indo-Pacific sailfish since 2011.
- Discards are unknown for most industrial fisheries, mainly longliners (for which they are presumed to be moderate-high).

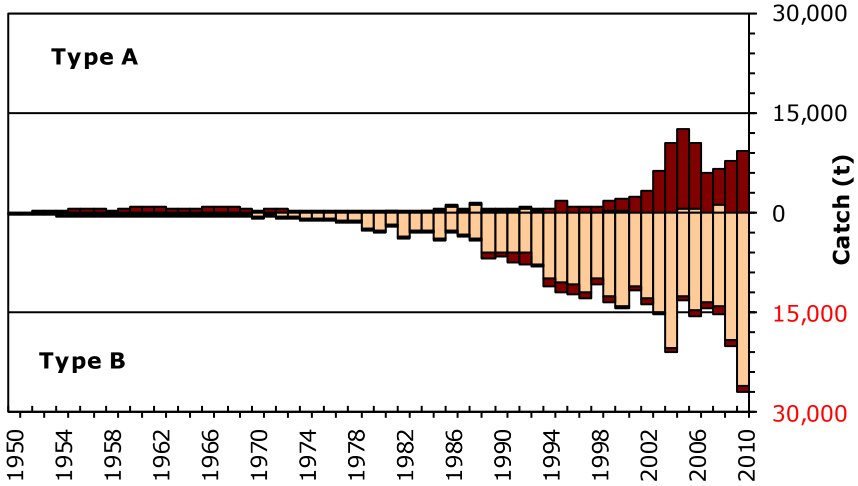


Fig. 19. Uncertainty of annual catch estimates for Indo-Pacific sailfish. (Data as of July 2012)

*Catches below the zero-line (**Type B**) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (**Type A**) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.*

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

Average fish weight can only be assessed for the longline fishery of Japan since 1970 and the gillnet/longline fishery of Sri Lanka since the late 1980s (**Fig. 20**). The number of specimens measured on Japanese longliners in recent years is, however, very low. Furthermore, the specimens discarded might be not accounted for in industrial fisheries, where they are presumed to be of lower size (possible bias of existing samples).

Catch-at-Size(Age) tables have not been built for this species due to a lack of information reported by CPCs. Fish size is derived from various length and weight information, however the reliability of the size data is reduced when relatively few fish out of the total catch are measured.

Sex ratio data have not been provided to the Secretariat by CPCs.

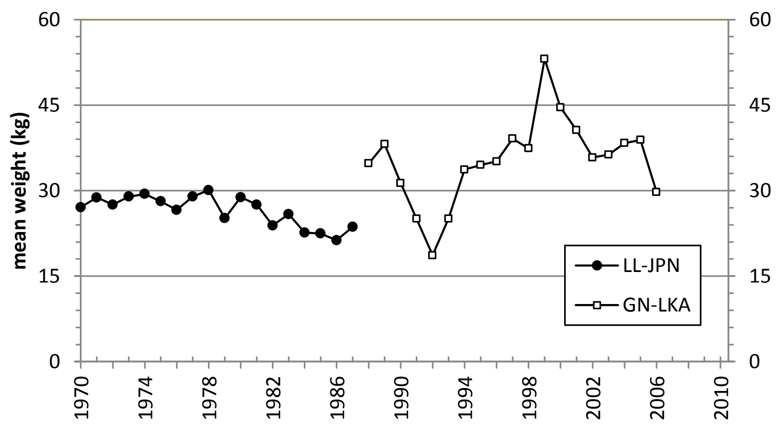


Fig. 20. Average weight of Indo-Pacific sailfish (kg) estimated from the size samples available for longliners of Japan (1970–2009) and gillnets of Sri Lanka (1980–2010).
NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

Swordfish (Xiphias gladius)

Catch trends

Swordfish are caught mainly using longlines (95%) and drifting gillnets (4%) (**Table 5, Fig. 21**). Between 1950 and 1980, catches of swordfish in the Indian Ocean slowly increased in tandem with the level of coastal state and distant water fishing nation longline effort targeting tunas and sharks (**Figs. 21, 22**). Swordfish were not targeted by industrial longline fisheries before the early 1990's, however with the introduction of night fishing using longlines baited with squid and light sticks, catches increased post 1990.

Since 2004, annual catches have declined steadily (**Fig. 22**), largely due to the continued decline in the number of active Taiwan,China longliners in the Indian Ocean (**Fig. 23**). Annual catches since 2004 have been dominated by the Taiwan,China and EU fleets (Spain, UK, France and Portugal), with the fishery extending eastward due to the effects of piracy actions (**Fig. 23**).

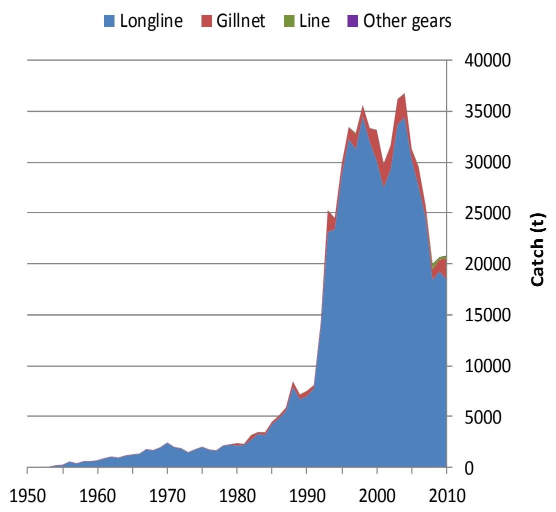


Fig. 21 Catches of swordfish per gear and year recorded in the IOTC Database (1960–2010).

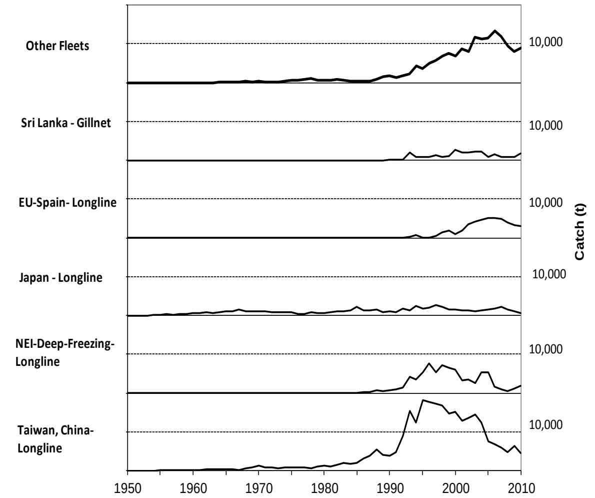


Fig. 23. Catches of swordfish by fleet recorded in the IOTC Database (1960–2010).

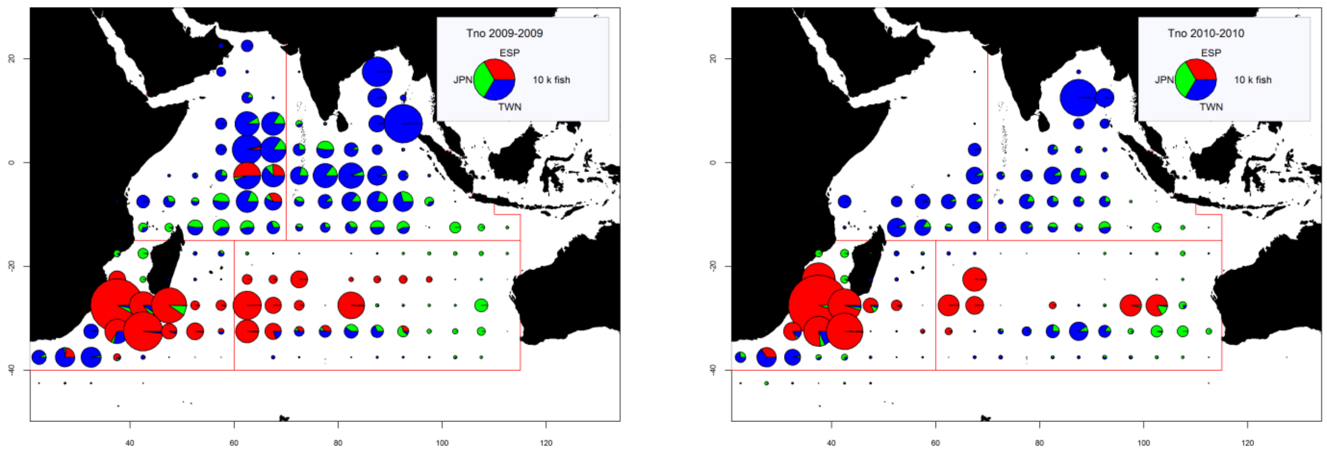


Fig. 23a–b. Time-area catches (total combined in tonnes) of swordfish as reported for the longline fleets of Japan (JPN), Taiwan,China (TWN), and EU-Spain (ESP), the latter directed at swordfish, for 2009 and 2010 by type of gear. Red lines represent the boundaries of the areas used for the assessments of swordfish.

TABLE 5. Best scientific estimates of the catches of swordfish by type of fishery for the period 1950–2010 (in metric tons). Data as of July 2012.

Fishery	By decade (average)						By year (last ten years)										
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
ELL	0	0	0	9.2	1,847	10,417	7,971	8,902	10,700	13,415	15,625	13,629	12,009	8,580	8,262	9,708	7,790
LL	287	1,430	2,139	4,363	21,602	17,252	19,623	20,479	23,060	21,035	14,685	14,187	12,820	10,262	11,211	9,320	7,987
OT	37	37.7	42.4	293.3	1,069	2,249	2,356	2,532	2,665	2,554	1,589	2,503	1,783	2,103	1,364	2,298	3,854
Total	**323**	**1,468**	**2,181**	**4,665**	**24,519**	**29,918**	**29,950**	**31,913**	**36,425**	**37,004**	**31,899**	**30,319**	**26,612**	**20,945**	**20,837**	**21,326**	**19,631**

Fisheries: Swordfish longline (**ELL**); Other longline (**LL**); Other fisheries (**OT**)

TABLE 6. Best scientific estimates of the catches of swordfish by fishing area for the period 1950–2010 (in metric tons). Data as of September 2012.

Area	By decade (average)						By year (last ten years)										
	1950s	1960s	1970s	1980s	1990s	2000s	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
NW	117	549.7	639.1	1,452	7,234	9,476	7,878	12,187	14,727	12,012	10,827	10,112	8,211	6,119	3,783	2,214	1,456
SW	14	255.5	404.9	620.5	8,608	7,667	8,980	7,620	4,110	6,312	9,771	8,914	7,420	6,214	6,543	8,112	6,669
NE	155	450.8	751.1	2,095	5,905	6,998	6,771	6,376	9,088	9,017	5,476	6,938	5,780	5,092	7,440	7,414	8,469
SE	37	204.2	310.8	355.7	2,681	5,757	6,293	5,684	8,469	9,630	5,810	4,350	5,188	3,516	3,067	3,575	3,028
OT	0	7.5	75.1	142	90.3	20.6	28	45	31	33	15	5	14	5	5	10	8
Total	**323**	**1,468**	**2,181**	**4,665**	**24,519**	**29,918**	**29,950**	**31,912**	**36,425**	**37,004**	**31,899**	**30,319**	**26,613**	**20,946**	**20,838**	**21,325**	**19,630**

Areas: Northwest Indian Ocean (**NW**); Southwest Indian Ocean (**SW**); Northeast Indian Ocean (**NE**); Southeast Indian Ocean (**SE**); Southern Indian Ocean (**OT**)

Uncertainty of time–area catches

Retained catches are fairly well known (**Fig. 24**); however catches are uncertain for:

- **Drifting gillnet** fisheries of **Iran** and **Pakistan**: To date, Iran has not reported catches of swordfish for its gillnet fishery. Although Pakistan has reported catches of swordfish they are considered to be too low for a driftnet fishery (catches of swordfish in recent years represent less than 2% of the total catches of swordfish in the Indian Ocean).
- **Longline** fishery of **Indonesia**: The catches of swordfish for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years due to insufficient sampling coverage. Although the new catches estimated by the Secretariat are thought to be more accurate, swordfish catches remain uncertain, especially in recent years (where they represent around 6% of the total catches of swordfish in the Indian Ocean).
- **Longline** fishery of **India: India** has reported very incomplete catches and catch-and-effort data for its longline fishery. Although the new catches estimated by the Secretariat are thought to be more accurate, catches of swordfish remain uncertain (catches of swordfish in recent years represent less than 3% of the total catches of swordfish in the Indian Ocean).
- **Longline** fleets from **non-reporting** countries (NEI): The Secretariat had to estimate catches of swordfish for a fleet of longliners targeting tunas or swordfish and operating under flags of various non-reporting countries. The catches estimated since 2006 are, however, low (they represent around 6% of the total catches of swordfish in the Indian Ocean).
- There have not been significant changes to the catch series of swordfish since the WPB in 2010. Changes since the last WPB refer to revisions of historic data series for the artisanal fisheries of Indonesia and India. These changes, however, did not lead to significant changes in the total catch estimates.
- **Discards** are believed to be low although they are unknown for most industrial fisheries, mainly longliners. Discards of swordfish may also occur in the driftnet fishery of Iran, as this species has no commercial value in this country.

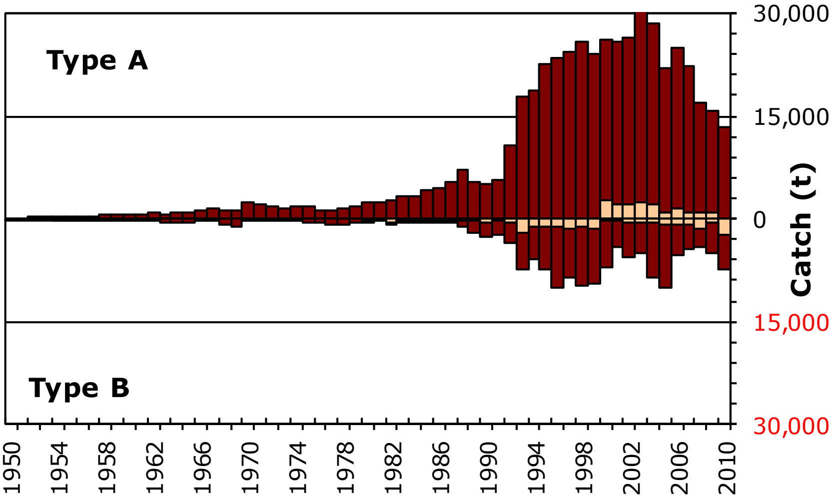


Fig. 24. Uncertainty of annual catch estimates for swordfish (Data as of July 2012).

Catches below the zero-line (Type B) refer to fleets that do not report catch data to the IOTC (estimated by the IOTC Secretariat), do not report catch data by gear and/or species (broken by gear and species by the IOTC Secretariat) or any of the other reasons provided in the document. Catches over the zero-line (Type A) refer to fleets for which no major inconsistencies have been found to exist. Light bars represent data for artisanal fleets and dark bars represent data for industrial fleets.

Fish size or age trends (e.g. by length, weight, sex and/or maturity)

In general, the amount of catch for which size data for the species are available before 2005 is still very low and the number of specimens measured per stratum has been decreasing in recent years.

- **Average fish weight** (**Fig. 25**) can be assessed for several industrial fisheries although they are incomplete or poor quality for most fisheries before the early-80s and in recent years (low sampling coverage and time-area coverage of longliners from Japan). The average weights of swordfish are variable but show no clear trend. It is considered encouraging that there are no clear signals of declines in the size-based indices, but these indices should be carefully monitored, as females mature at a relatively large size, therefore, a reduction in the biomass of large animals could potentially have a strong effect on the spawning biomass.
- **Catch-at-Size(Age)** data are available but the estimates are thought to have been compromised for some years and fisheries due to:
    - the uncertainty in the catches of swordfish for the drifting gillnet fisheries of **Iran** and the fresh-tuna longline fishery of **Indonesia**.
    - the total lack of size data before the early-70s and poor coverage before the early-80s and for most artisanal fisheries (**Pakistan**, **India**, **Indonesia**).
    - the paucity of size data available from industrial longliners since the early-1990s (**Japan**, **Philippines**, **India** and **China**).
    - the lack of time-area catches for some industrial fleets (**Indonesia**, **India**, NEI).
    - the paucity of biological data available, notably sex-ratio and sex-length-age keys.

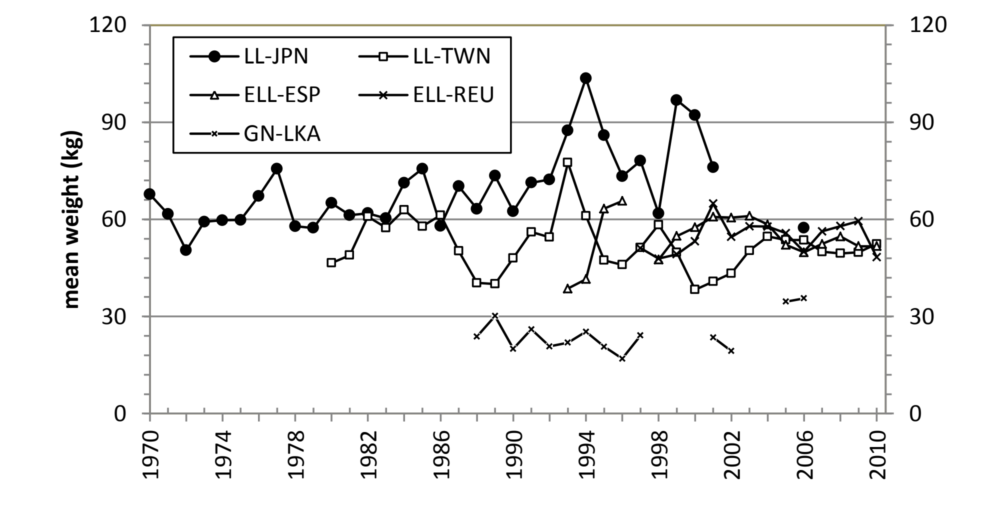


Fig. 25. Average weight of swordfish (kg) estimated from the size samples available for longliners of Japan (1970–2009), Taiwan,China (1980–2010), EU-Spain (1993–2010), and EU-France-Reunion (1997–2010); and the gillnet fishery of Sri Lanka (1988–2010).
NOTE: Average weights are shown only for years in which 300 or more specimens were sampled for length

APPENDIX VI

MAIN ISSUES IDENTIFIED RELATING TO THE STATISTICS OF BILLFISH

Extract from IOTC–2012–WPB10–07

The following list is provided by the Secretariat for the consideration of the WPB. The list covers the main issues which the Secretariat considers to negatively affect the quality of the statistics available at the IOTC, by type of dataset and fishery.

1. Catch-and-Effort data from Artisanal Fisheries:

- **Drifting gillnet** fisheries of **Iran** and **Pakistan**: To date, Iran has not reported catches of swordfish and marlins for its gillnet fishery. Although Pakistan has reported catches of swordfish and black marlin, they are considered to be too low for a driftnet fishery and the catches of black marlin are thought to contain other marlins (misidentification). Although very significant catches of marlins are likely to be taken on driftnet fisheries, the paucity of the data available makes it difficult to assess catch levels for driftnet fleets.
- **Gillnet/longline** fishery of **Sri Lanka**: In recent years Sri Lanka has caught over 20% of the catches of marlins in the Indian Ocean. Although Sri Lanka has reported catches of marlins by species for its gillnet/longline fishery, the catch ratio of blue marlin to black marlin has changed dramatically over time. This is thought to be a sign of frequent misidentification rather than the effect of changes in catch rates for this fishery. Although the IOTC Secretariat adjusted the catches of marlins using proportions derived from years with good monitoring of catches by species, the catches estimated remain uncertain.
- **Artisanal** fisheries of **Indonesia**: The catches of billfish reported by Indonesia for its artisanal fisheries in recent years are considerably higher than those reported in the past, and represent around 9% of the total catches of billfish in the Indian Ocean. In 2011 the Secretariat revised the complete nominal catch dataset for Indonesia, using information from various sources, including official reports. However, the quality of the dataset for the artisanal fisheries of Indonesia is thought to be poor, with a likely underestimation of catches of billfish in recent years.
- **Artisanal** fisheries of **India**: In early 2012 the Secretariat revised the complete nominal catch dataset for India, using new information available. The catches of billfish estimated in recent years represent around 20% of the total catches in the Indian Ocean, and refer mainly to Indo-Pacific sailfish. To date, India has not reported catch-and-effort data for its artisanal fisheries.

2. Catch-and-Effort data from Sport Fisheries:

- **Sport** fisheries of **Australia, EU,France(Reunion)**, **India**, **Indonesia**, **Madagascar**, **Mauritius**, **Oman, Seychelles**, **Sri Lanka**, **Tanzania**, **Thailand** and **UAE**: To date, no data have been received from any of the referred sport fisheries. Sport fisheries are known to catch billfish species, in particular blue marlin, black marlin and Indo-Pacific sailfish. Although data are available from other sport fisheries in the region (Kenya, Mauritius, Mozambique, South Africa), this information cannot be used to estimate levels of catch for other fisheries.

3. Catch-and-Effort data from Industrial Fisheries:

- **Longline** fishery of **Indonesia**: The catches of swordfish and marlins estimated for the fresh tuna longline fishery of Indonesia may have been underestimated in recent years due to them not being sampled sufficiently in port and to the lack of logbook data from which to derive estimates. The catches of billfish estimated in recent years (all species combined) represent around 10% of the total catches in the Indian Ocean, especially swordfish and blue marlin.
- **Longline** fishery of **India**: In recent years, India has reported very incomplete catches and catch-and-effort data for its commercial longline fishery The Secretariat has estimated total catches for this period using alternative sources, the final catches estimated considerably higher than those reported (representing 3.5% of the total catches of billfish in recent years).

- **Longline** fishery of the **Republic of Korea**: The nominal catches and catch-and-effort data series for billfish for the longline fishery of Korea are conflicting, with nominal catches of swordfish and marlins lower than the catches reported as catch-and-effort for some years. Although in 2010 the IOTC Secretariat revised the nominal catch dataset to account for catches reported as catch-and-effort, the quality of the estimates remains unknown. However, the catches of longliners of the Rep. of Korea in recent years are very small.
- **Longline** fishery of **EU,Spain:** To date, the Secretariat has not received catch-and-effort data for marlins and sailfish for the longline fishery of EU-Spain.
- **Purse seine** fisheries of **Seychelles**, **Thailand**, **Iran** and **Japan**: To date, the referred countries have not reported catches of billfish from purse seiners, although they are thought to be very low.

4. Size data from All Fisheries:

- **Longline** fishery of **Taiwan,China**: Size data have been available for the longline fishery of Taiwan,China since 1980; however, the length frequency distributions of striped marlin and blue marlin differ from those reported by Japan for its longline fishery, with average weights of striped marlin likely to be too large for a longline fishery. Therefore, it is likely that there has been overspread miss-identification of striped marlin and blue marlin on board longliners flagged in Taiwan,China.
- **Gillnet** fisheries of **Iran** and **Pakistan:** To date, Iran and Pakistan have not reported size frequency data for their gillnet fisheries.
- **Gillnet/longline** fishery of **Sri Lanka:** Although Sri Lanka has reported length frequency data for swordfish and marlins in recent years, the lengths reported are considered highly uncertain, due to misidentification of marlins and likely sampling bias (large specimens of swordfish and marlins are highly processed and not sampled).
- **Longline** fisheries of **India** and **Oman:** To date, India and Oman have not reported size frequency data for their longline fisheries.
- **Longline** fishery of **Indonesia**: Indonesia has reported size frequency data for its fresh-tuna longline fishery in recent years. However, the samples cannot be fully disaggregated by month and fishing area (5x5 grid) and refer mostly to the component of the catch that is unloaded fresh. The quality of the samples in the IOTC database is for this reason uncertain.
- **Fresh-tuna longline** fishery of **Taiwan,China[1]:** Data are only available for striped marlin and swordfish for the year 2010, with no size data available for other species or years.
- **Longline** fishery of **Japan:** The number of samples reported and total number of fish sampled for the longline fishery of Japan since 2000 has been very low.
- **Artisanal** fisheries of **India** and **Indonesia**: To date, India and Indonesia have not reported size frequency data for their artisanal fisheries.

5. Biological data for all billfish species:

- Industrial **longline** fisheries, in particular **Taiwan,China**, **Indonesia**, **EU**, **China** and the **Republic of Korea**: The Secretariat had to use length-age keys, length-weight keys, and processed weight-live weight keys for billfish species from other oceans due to the general paucity of biological data available from the fisheries indicated.
- Industrial **longline** fisheries, in particular **Taiwan,China**, **Indonesia**, **EU**, **China** and the **Republic of Korea**: there has not been regular reporting of length frequency data by sex from any of the referred fisheries.

[1] Refers to Taiwan Province of China

APPENDIX VII
DRAFT RESOURCE STOCK STATUS SUMMARIES – BLACK MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien

Status of the Indian Ocean Black Marlin Resource (*Makaira indica*)

TABLE 1. Status of black marlin (*Makaira indica*) in the Indian Ocean

Area[1]	Indicators		2012 stock status determination 2010[2]
Indian Ocean	Catch 2010:	6,935 t	Uncertain
	Average catch 2006–2010:	6,085 t	
	MSY (range):	unknown	
	F_{2009}/F_{MSY} (range):	unknown	
	SB_{2009}/SB_{MSY} (range):	unknown	
	SB_{2009}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

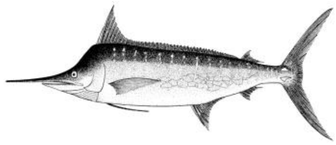
Stock status. No quantitative stock assessment is currently available for black marlin in the Indian Ocean; due to a lack of fishery data and poor quality of available data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

Outlook. Longline catch and effort for black marlin in recent years has continued to increase to a total of 7,221 tonnes in 2009. Although a lower catch of 6,935 tonnes was caught in 2010, the pressure on the Indian Ocean stock as a whole, remains highly uncertain. Thus, there remains insufficient information to evaluate the effect this will have on the resource. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of black marlin are highly uncertain and need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

APPENDIX VIII
DRAFT RESOURCE STOCK STATUS SUMMARIES – BLUE MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Blue Marlin Resource (*Makaira nigricans*)

TABLE 1. Status of Indo-Pacific blue marlin (*Makaira nigricans*) in the Indian Ocean.

Area[1]	Indicators		2012 stock status determination 2010[2]
Indian Ocean	Catch 2010:	10,660 t	Uncertain
	Average catch 2006–2010:	9,246 t	
	MSY (range):	unknown	
	F_{2009}/F_{MSY} (range):	unknown	
	SB_{2009}/SB_{MSY} (range):	unknown	
	SB_{2009}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished (SB_{year}/SB_{MSY}≥ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)		
Stock not subject to overfishing (F_{year}/F_{MSY}≤ 1)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

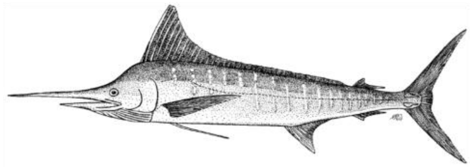
Stock status. No quantitative stock assessment is currently available for blue marlin in the Indian Ocean which is considered developed enough for the provision of management advice. Due to a lack of reliable fishery data and poor quality of available data for several gears, only very preliminary stock indicators can be used. The standardised longline CPUE series suggest that there was a decline in the early 1980s, followed by a constant or slightly increasing abundance over the last 20 years. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore the stock status is determined as being *uncertain* (Table 1). However, aspects of species biology, productivity and fisheries combined with the data on which to base a quantitative assessment is a cause for concern.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, although 2010 catches increased to 10,660 t. There is insufficient information to evaluate the effect this will have on the resource at this point in time. Given the concerning results obtained from the preliminary stock assessments carried out in 2012 for blue marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out in 2013. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of blue marlin are highly uncertain and need to be reviewed as problems in the catch series from the main fleets catching blue marlin were identified in 2012.
- improvement in data collection and reporting is required to further improve the assessment of the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

APPENDIX IX
DRAFT RESOURCE STOCK STATUS SUMMARIES – STRIPED MARLIN

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Striped Marlin Resource (*Tetrapturus audax*)

TABLE 1. Status of striped marlin (*Tetrapturus audax*) in the Indian Ocean.

Area[1]	**Indicators**		**2012 stock status determination**
			2010[2]
Indian Ocean	Catch 2010:	2,090 t	Uncertain
	Average catch 2006–2010:	2,531 t	
	MSY (range):	unknown	
	F_{2010}/F_{MSY} (range):	unknown	
	SB_{2010}/SB_{MSY} (range):	unknown	
	SB_{2010}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished(SB_{year}/SB_{MSY}< 1)	Stock not overfished ($SB_{year}/SB_{MSY}\geq$ 1)
Stock subject to overfishing(F_{year}/F_{MSY}> 1)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq$ 1)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

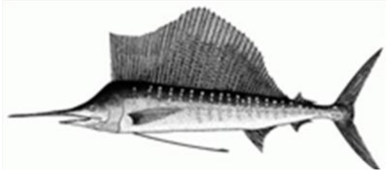
Stock status. No quantitative stock assessment is currently available for striped marlin in the Indian Ocean which is considered developed enough for the provision of management advice. Due to a lack of reliable fishery data and poor quality of available data for several gears, only very preliminary stock indicators can be used. The standardised CPUE series suggest that there was a sharp decline in the early 1980s, followed by slower decline since 1990. This contrasts with the majority of non-standardised indicators which suggest a decline in abundance since the 1980s. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a quantitative assessment are a cause for considerable concern.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, however there is insufficient information to evaluate the effect this will have on the resource. Given the concerning results obtained from the preliminary stock assessments carried out in 2012 for striped marlin, the data and other inputs for stock assessment urgently needs to be revised so that a new assessment may be carried out in 2013. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of striped marlin are highly uncertain and need to be reviewed as problems in the catch series from the main fleets catching striped marlin were identified in 2012.
- improvement in data collection and reporting is required to further improve the assessment of the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

APPENDIX X
DRAFT RESOURCE STOCK STATUS SUMMARY – INDO-PACIFIC SAILFISH

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Indo-Pacific Sailfish Resource (*Istiophorus platypterus*)

TABLE 1. Status of Indo-Pacific sailfish (*Istiophorus platypterus*) in the Indian Ocean.

Area[1]	Indicators		2012 stock status determination 2010[2]
Indian Ocean	Catch 2010:	31,650 t	Uncertain
	Average catch 2006–2010:	26,077 t	
	MSY (range):	unknown	
	F_{2010}/F_{MSY} (range):	unknown	
	SB_{2010}/SB_{MSY} (range):	unknown	
	SB_{2010}/SB_0 (range):	unknown	

[1]Boundaries for the Indian Ocean = IOTC area of competence
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY}> 1$)	(red)	(orange)
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)	(yellow)	(green)

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. No quantitative stock assessment is currently available for Indo-Pacific sailfish in the Indian Ocean; due to a lack of fishery data and poor quality of available data for several gears, only preliminary stock indicators can be used. Therefore stock status remains *uncertain* (Table 1). However, aspects of the biology, productivity and fisheries for this species combined with the data poor status on which to base a more formal assessment are a cause for considerable concern. Research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

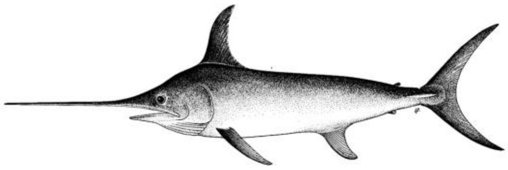
Outlook. The increase in longline catch and effort in recent years is a substantial cause for concern for the Indian Ocean stock as a whole, however there is not sufficient information to evaluate the effect this will have on the resource. The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is unknown.
- annual catches of Indo-Pacific sailfish are highly uncertain and need to be reviewed.
- improvement in data collection and reporting is required to assess the stock.
- research emphasis on improving indicators and exploration of stock assessment approaches for data poor fisheries are warranted.

APPENDIX XI

DRAFT RESOURCE STOCK STATUS SUMMARY – SWORDFISH

Indian Ocean Tuna Commission
Commission des Thons de l'Océan Indien
iotc ctoi



Status of the Indian Ocean Swordfish Resource (*Xiphias gladius*)

TABLE 1. Status of swordfish (*Xiphias gladius*) in the Indian Ocean.

Area[1]	Indicators		2012 stock status determination 2009[2]
Indian Ocean	Catch 2010:	21,326 t	
	Average catch 2006–2010:	24,008 t	
	MSY (4 models):	29,900 t–34,200 t	
	F_{2009}/F_{MSY} (4 models):	0.50–0.63	
	SB_{2009}/SB_{MSY} (4 models):	1.07–1.59	
	SB_{2009}/SB_0 (4 models):	0.30–0.53	

[1]Boundaries for the Indian Ocean stock assessment are defined as the IOTC area of competence.
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished($SB_{year}/SB_{MSY} < 1$)	Stock not overfished ($SB_{year}/SB_{MSY} \geq 1$)
Stock subject to overfishing($F_{year}/F_{MSY} > 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY} \leq 1$)		

INDIAN OCEAN STOCK – MANAGEMENT ADVICE

Stock status. All models suggest that the stock is above, but close to a biomass level that would produce MSY and current catches are below the MSY level. MSY-based reference points were not exceeded for the Indian Ocean population as a whole ($F_{2009}/F_{MSY} < 1$; $SB_{2009}/SB_{MSY} > 1$). Spawning stock biomass in 2009 was estimated to be 30–53% (from Table 1; Fig. 1) of the unfished levels.

Outlook. The decrease in longline catch and effort in recent years has lowered the pressure on the Indian Ocean stock as a whole, indicating that current fishing mortality would not reduce the population to an overfished state. There is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at current levels until 2019 (<11% risk that $B_{2019} < B_{MSY}$, and <9% risk that $F_{2019} > F_{MSY}$) (Table 2). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the whole Indian Ocean is 29,900–34,200 t (range of best point estimates from Table 2) and annual catches of swordfish should not exceed this estimate.
- if the recent declines in effort continue, and catch remains substantially below the estimated MSY of 30,000–34,000 t, then management measures are not required which would pre-empt current resolutions and planned management strategy evaluation. However, continued monitoring and improvement in data collection, reporting and analysis is required to reduce the uncertainty in assessments.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- advice specific to the southwest region is provided below, as requested by the Commission.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, but below the provisional limit reference point of $1.4*F_{MSY}$ (Fig. 1).
    b. **Biomass**: Current spawning biomass is considered to be above the target reference point of SB_{MSY}, and therefore above the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

TABLE 2. Aggregated Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across four assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	Alternative catch projections (relative to 2009) and probability (%) of violating reference point				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0–4	0–8	0–11	2–12	4–16
$F_{2012} > F_{MSY}$	0–1	0–2	0–9	0–16	6–27
$B_{2019} < B_{MSY}$	0–4	0–8	0–11	0–13	6–26
$F_{2019} > F_{MSY}$	0–1	0–2	0–9	0–23	7–31

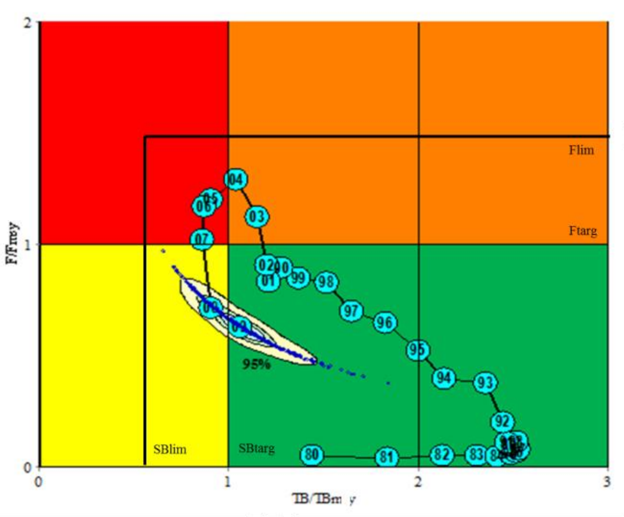


Fig. 1. ASPIC Aggregated Indian Ocean assessment Kobe plot (95% Confidence surfaces shown around 2009 estimate). Blue circles indicate the trajectory of the point estimates for the SB ratio and F ratio for each year 1950–2010. Target (Ftarg and SBtarg) and limit (Flim and SBlim) reference points are shown.

TABLE 3. Status of swordfish (*Xiphias gladius*) in the southwest Indian Ocean.

Area[1]	**Indicators**		**2012 stock status determination 2009**[2]
Southwest Indian Ocean	Catch 2010:	8,112 t	
	Average catch 2006–2010:	7,441 t	
	MSY (3 models):	7,100 t–9,400 t	
	F_{2009}/F_{MSY} (3 models):	0.64–1.19	
	SB_{2009}/SB_{MSY} (3 models):	0.73–1.44	
	SB_{2009}/SB_0 (3 models):	0.16–0.58	

[1]Boundaries for southwest Indian Ocean stock assessment are defined in IOTC–2011–WPB09–R.
[2]The stock status refers to the most recent years' data used for the assessment.

Colour key	Stock overfished ($SB_{year}/SB_{MSY}< 1$)	Stock not overfished ($SB_{year}/SB_{MSY}\geq 1$)
Stock subject to overfishing ($F_{year}/F_{MSY}> 1$)		
Stock not subject to overfishing ($F_{year}/F_{MSY}\leq 1$)		

Southwest Indian Ocean – Management Advice

Stock status. Most of the evidence provided to the WPB indicated that the resource in the southwest Indian Ocean has been overfished in the past decade and biomass remains below the level that would produce MSY (B_{MSY}). Recent declines in catch and effort have brought fishing mortality rates to levels below F_{MSY} (Table 3). Although the catches of swordfish in the southwest Indian Ocean increased in 2010 to 8,112 t, which equals 121.5% of the recommended maximum catch of 6,678 t agreed to by the SC in 2011, this is not considered to be a major threat to the status of the stock as the probabilities of violating target reference points in 2012 by catching 120% of the recommended catch are less than 18% for F_{MSY} and less than 30% for B_{MSY} (Table 4).

Outlook. The decrease in catch and effort over the last few years in the southwest region has reduced pressure on this resource. However, in 2010, catches exceeded the maximum recommended by the WPB09 and SC14 in 2011 (6,678 t), with 8,112 t caught in this region. The WPB09 estimated that there is a low risk of exceeding MSY-based reference points by 2019 if catches reduce further or are maintained at 2009 levels (<25% risk that $B_{2019} < B_{MSY}$, and <8% risk that F2019 > F_{MSY}). There is a risk of reversing the rebuilding trend if there is any increase in catch in this region (Table 4). The following key points should be noted:

- the Maximum Sustainable Yield estimate for the southwest Indian Ocean is 7,100–9,400 t (range of best point estimates from Table 3).
- catches in the southwest Indian Ocean should be maintained at levels at or below those observed in 2009 (6,678t), until there is clear evidence of recovery and biomass exceeds B_{MSY}.
- in 2010, catches have exceeded the maximum recommended by the WPB09 and SC14 (6,678 t), with 8,112 t caught in this region.
- the Kobe strategy matrix illustrates the levels of risk associated with varying catch levels over time and could be used to inform management actions.
- provisional reference points: Noting that the Commission in 2012 agreed to Recommendation 12/14 *on interim target and limit reference points*, the following should be noted:
    a. **Fishing mortality**: Current fishing mortality is considered to be below the provisional target reference point of F_{MSY}, and thus, below the provisional limit reference point of $1.4*F_{MSY}$.
    b. **Biomass**: Current spawning biomass is considered to be below the target reference point of SB_{MSY}, and therefore, below the limit reference point of $0.4*SB_{MSY}$ (Fig. 1).

TABLE 4. Southwest Indian Ocean assessment - Kobe 2 Strategy Matrix, indicating a range of probabilities across three assessment approaches. Probability (percentage) of violating the MSY-based reference points for five constant catch projections (2009 catch level, ± 20% and ± 40%) projected for 3 and 10 years.

Reference point and projection timeframe	**Alternative catch projections (relative to 2009) and probability (%) of violating reference point**				
	60%	**80%**	**100%**	**120%**	**140%**
$B_{2012} < B_{MSY}$	0–15	0–20	0–25	0–30	12–32
$F_{2012} > F_{MSY}$	0–1	0–5	0–8	0–18	13–34
$B_{2019} < B_{MSY}$	0–15	0–20	0–25	0–32	18–34
$F_{2019} > F_{MSY}$	0–1	0–5	0–8	0–18	19–42